

*Flood Damage Reduction  
Shore & Bank Protection  
Navigation*

# *Water Resources Development*

*North Hartland Lake*



V E R M O N T



**US Army Corps  
of Engineers**  
New England Division

On the Cover: *North Hartland Lake, Hartland, Vermont*

# The work of the U.S. Army Corps of Engineers in Vermont

This booklet presents a brief description of water resources projects completed by the U.S. Army Corps of Engineers in Vermont. It describes the role of the Corps in planning and building water resource improvements and explains the procedure leading to the authorization of such projects.

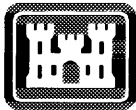
For ease of reference, the material is arranged according to the type of project, i.e. flood damage reduction, navigation, or shore and bank protection. There is also a reference at the end of the booklet that lists Corps' projects by community. A map showing the location of all Corps projects in the state is provided on the underleaf of this page. As a result of river basin boundaries, projects in eastern Vermont were built by the Corps' New England Division in Waltham, Massachusetts, and projects in western Vermont were constructed by the Corps' New York District in New York City. Projects built by the New York District are so indicated in the text.

The Corps of Engineers water resources development program exerts a significant impact on Vermont's physical, economic, and social environment. This publication affords citizens the opportunity to learn about the various projects and to determine how they can participate in decisions regarding present and future activities.

Before taking measures to resolve water resource problems, the New England Division performs individual studies on each affected area to determine if a Civil Works project is feasible. Each study examines a wide range of potential solutions based on economic and engineering practicality, acceptability, and impact on the environment. These on-going studies are discussed in detail in each of the quarterly New England Division State Update Reports which are available by request through the Public Affairs Office.

For further information, call the Corps of Engineers at 617-647-8237, or write:

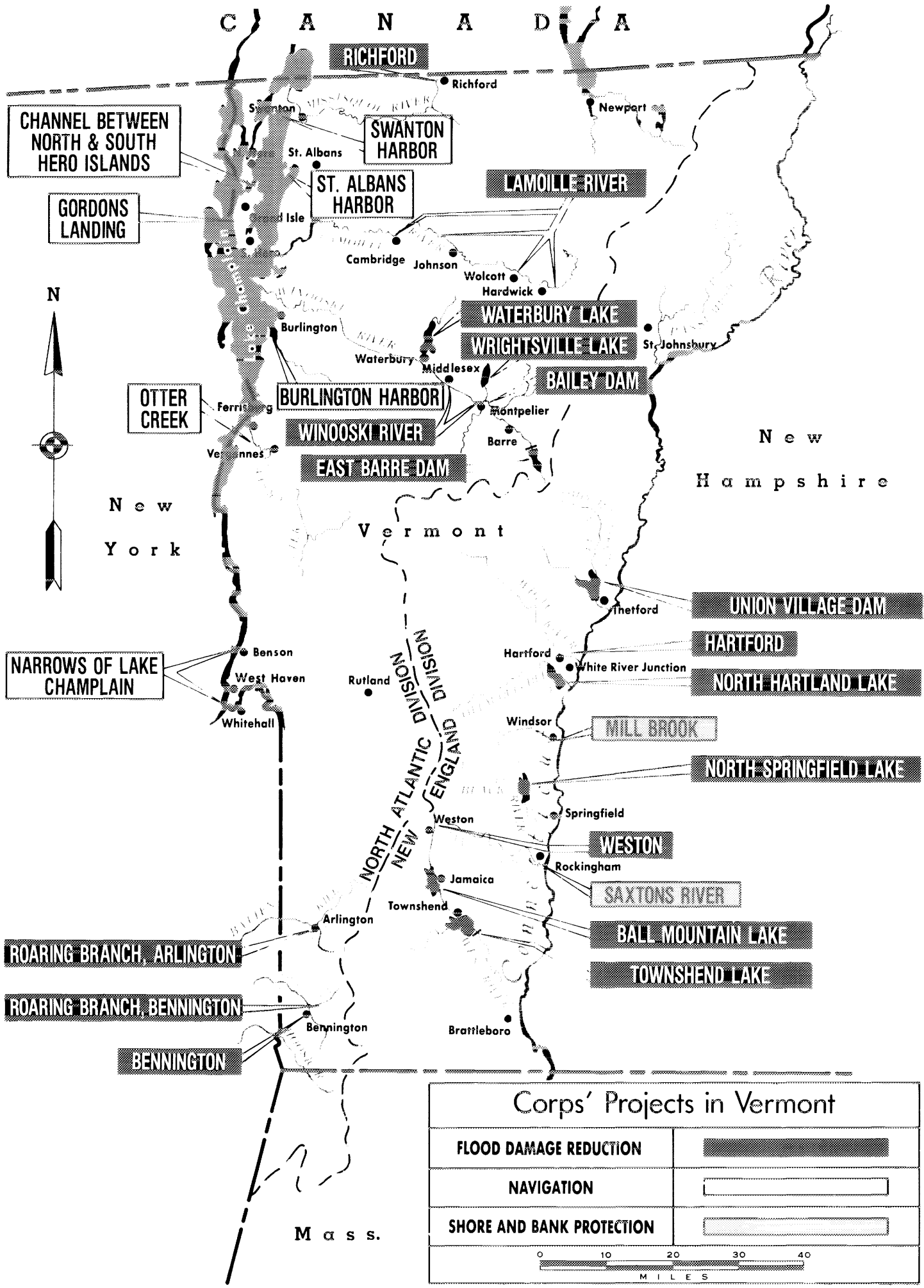
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**US Army Corps  
of Engineers**  
New England Division



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C A N A D A

**RICHFORD**

**CHANNEL BETWEEN  
NORTH & SOUTH  
HERO ISLANDS**

**GORDONS  
LANDING**

**SWANTON  
HARBOR**

**ST. ALBANS  
HARBOR**

**LAMOILLE RIVER**

**OTTER  
CREEK**

**BURLINGTON HARBOR**

**WINOOSKI RIVER**

**EAST BARRE DAM**

**WATERBURY LAKE**

**WRIGHTSVILLE LAKE**

**BAILEY DAM**

New  
Hampshire

New  
York

Vermont

**NARROWS OF LAKE  
CHAMPLAIN**

**UNION VILLAGE DAM**

**HARTFORD**

**NORTH HARTLAND LAKE**

**MILL BROOK**

**NORTH-SPRINGFIELD LAKE**

**WESTON**

**SAXTONS RIVER**

**BALL MOUNTAIN LAKE**

**TOWNSHEND LAKE**

**ROARING BRANCH, ARLINGTON**

**ROARING BRANCH, BENNINGTON**

**BENNINGTON**

M a s s .



US Army Corps  
of Engineers  
New England Division

*To Our Readers:*

*The Corps of Engineers was formed some 218 years ago to be responsive to the needs of a young nation. And while the nature of our work has changed with time, our basic purpose remains — to be responsive to America's needs.*

*Clearly, the Nation's concern for the environment has permeated the Corps. Our environmental commitment has never been greater. Authority granted by the Water Resources Development Act of 1990 puts focus on the environment as a mission and promises restoration of wetlands and habitats for fish and wildlife. The 1992 legislation calls for the improvement and protection of our Nation's water resources infrastructure.*

*Responding to the recent outbreak of natural disasters has provided the Corps an outstanding opportunity to serve. From precise measures in controlling the precarious Chicago Flood, to the massive aid provided for the victims of Hurricanes Andrew and Iniki and Typhoon Omar, Corps people showed their courage, commitment and tenacity.*

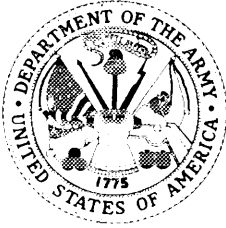
*We continue responding to our customers' desires to be more involved with projects on a day-to-day basis. The Corps has achieved a major cultural shift with project management. It has resulted in greater accountability to our customers and ultimately projects which better reflect the needs of the community.*

*Partnering is yet another positive cultural shift in the Corps' business practices, particularly in civil works construction. A local sponsorship kit walks customers through the complexities of Corps projects. Under the Coastal America program, six federal agencies work together to solve environmental problems along the Nation's shoreline. A technique related to partnering, alternate dispute resolution, creates an atmosphere in which the clash of differing viewpoints can grow into creative solutions and prevent costly legal disputes.*

*And of course, we still respond to the needs of American families. As one of the Nation's largest providers of outdoor recreation, the Corps operates 461 lakes and other water resources projects. It's a responsibility we take seriously, using the opportunity to help others appreciate our valuable and delicate natural resources.*

*This booklet is one in a series detailing water resource programs in the 50 states and U.S. possessions. I hope you will find it interesting and feel some pride in ownership.*

Arthur E. Williams  
Lieutenant General, USA  
Chief of Engineers



*To Our Readers:*

*The U.S. Army Corps of Engineers has a long and proud history of applying its expertise in engineering and related disciplines to meet the Nation's needs. Over the years, its activities have evolved; however, since 1824, the central focus of its civil mission has been the development of the Nation's water resources. With an annual program of over \$3 billion for civil projects, the Corps is the Federal Government's largest water resources development agency. The Corps develops projects that have proven to be wise investments. These projects have reduced flood damages; provided safe, low cost waterborne transportation; generated hydroelectric power; provided water for the public, industry and agriculture; offered opportunities for recreation; and helped the environment. They return to the public benefits that far outweigh their costs.*

*Corps civil works activities reflect partnership. All Corps projects begin when non-Federal interests see a water-related problem and petition Congress for a solution. Under provisions of the Water Resources Development Act of 1986, once the Corps conducts a reconnaissance study to determine whether a feasible project is likely, these sponsors provide a share of the funding for the feasibility study upon which a project will be based. They also provide a share the cost of the project's design and construction once Congress has authorized the project and provided construction funds. During the period 1986-1994, non-Federal sponsors signed 286 cooperative agreements with the Department of the Army for cost sharing of project construction.*

*The Corps' engineering expertise and responsiveness has stood the Nation in good stead during times of natural disaster. During 1994, the Corps continued to rehabilitate levees damaged by the Midwest Flood of 1993 and responded to the Northridge, California, Earthquake and the floods that ravaged the Southeast.*

*Whatever challenges arise in the decades ahead, I have no doubt that the Army Corps of Engineers will be equal to the task.*

A handwritten signature in black ink, reading "John Zirschky". The signature is fluid and cursive, with the first name "John" and last name "Zirschky" clearly distinguishable.

John H. Zirschky  
Acting Assistant Secretary  
of the Army (Civil Works)

# Table of Contents

<b>A. U.S. ARMY CORPS OF ENGINEERS PROGRAMS AND SERVICES</b>	1	Richford	42
<b>I. Civil Works Overview</b>	3	Roaring Branch, Arlington	43
Introduction	4	Roaring Branch, Bennington	43
Authorization and Planning Process for Water Resource Projects	6	Weston	44
Navigation	6	Winooski River, Middlesex and Montpelier	44
Flood Control and Flood Plain Management	7	<b>III. Navigation</b>	46
Flooding in New England	9	Navigation Projects in Vermont	47
Reservoir Control Center	14	Burlington Harbor	50
Shore and Hurricane Protection	16	Channel Between the North and South Hero Islands	50
Hydropower	17	Gordons Landing	51
Water Supply	18	Narrows of Lake Champlain	51
Environmental Quality	18	Otter Creek	52
Regulatory Programs	19	St. Albans Harbor	52
Recreation	20	Swanton Harbor	52
Emergency Response and Recovery	21	<b>IV. Shore and Bank Protection</b>	54
<b>B. DESCRIPTION OF PROJECTS</b>	23	Shore and Bank Protection Projects in Vermont	55
<b>I. River Basins</b>	24	Mill Brook, Brownsville	56
Connecticut	25	Saxtons River, Rockingham	56
Hudson	26	<b>D. APPENDIX</b>	57
Lake Champlain	27	<b>I. Communities with Corps Projects</b>	58
<b>II. Flood Damage Reduction</b>	28	<b>II. Glossary</b>	60
<i>Dams and Reservoirs</i>	29	<b>III. Index</b>	62
Ball Mountain Lake in Jamaica	30		
East Barre Dam in Barre	31		
North Hartland Lake in Hartland	32		
North Springfield Lake in Springfield	33		
Townshend Lake in Townshend	34		
Union Village Dam in Thetford	34		
Waterbury Reservoir in Waterbury	36		
Wrightsville Reservoir in Montpelier	37		
<i>Local Protection Projects</i>	39		
Bailey Dam, Montpelier	40		
Bennington	40		
Hartford	41		
Lamoille River, Cambridge and Hardwick	42		

# U.S. ARMY CORPS OF ENGINEERS PROGRAMS AND SERVICES

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# CIVIL WORKS OVERVIEW

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# INTRODUCTION

The Corps traces its history back to April 26, 1775, seven days after the first shots of the American Revolution were fired at Lexington, Massachusetts. Recognizing that the need for military engineering skill would be important in the war with England, the Massachusetts Provincial Congress appointed Boston native Richard Gridley to the rank of Colonel and Chief Engineer of the troops being raised in the colony.

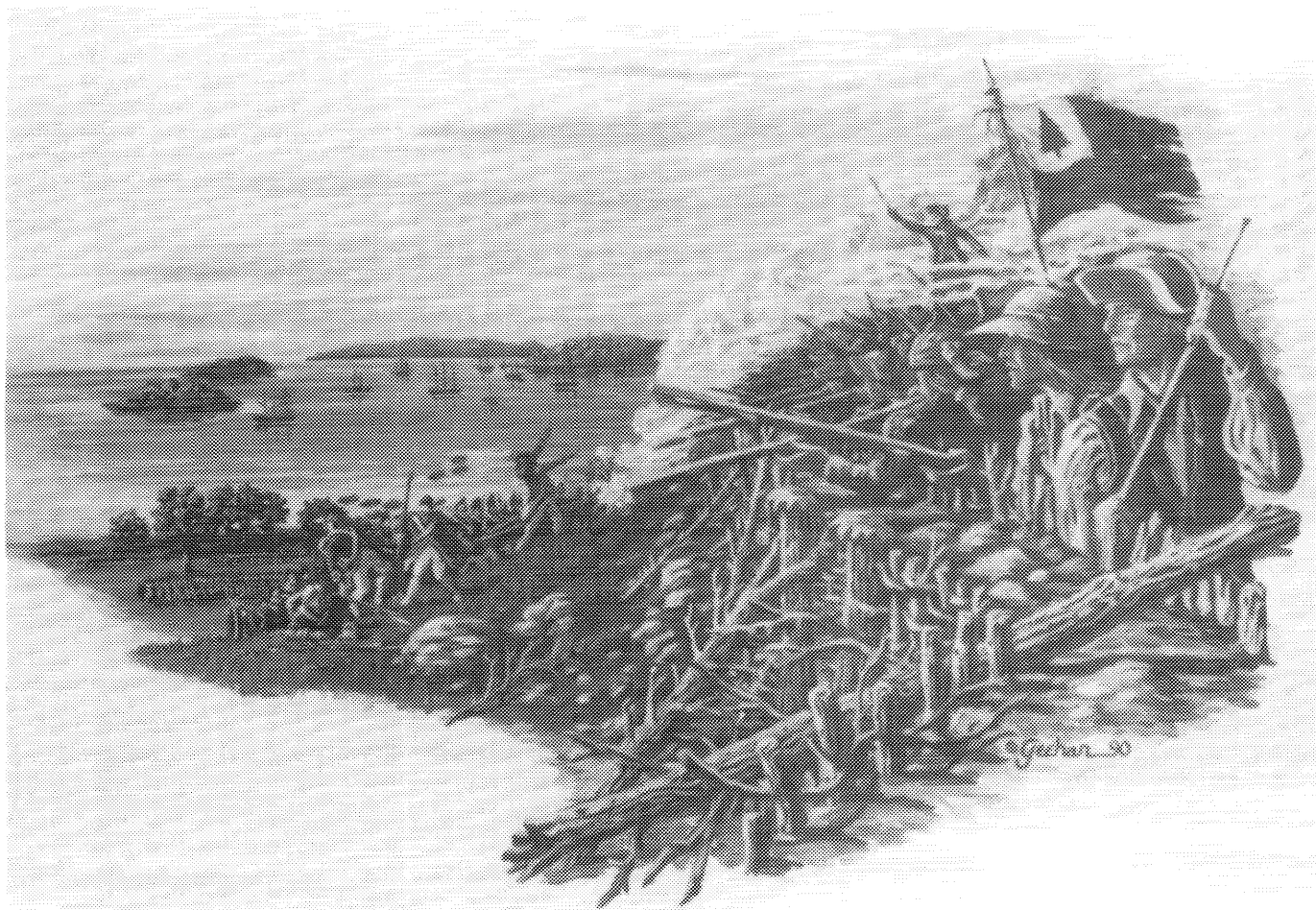
In the early morning hours of June 17, 1775, Gridley, working under the cover of darkness, constructed a well-designed earthwork on Breed's Hill that proved practically invulnerable to British cannon. The British eventually took the hill (later called the Battle of Bunker Hill) when the patriots ran out of gunpowder, but at a cost in casualties greater than any other engagement of the war.

Gridley was to play other critical roles in the early days of the Revolution. On the evening of March 4, 1776, Gridley, along with 2000 men and 360 oxcarts loaded with entrenching materials, moved into Dorchester Heights. By daylight, two strong protective barriers looked down at the

British. An astonished General Howe, Commander of the British forces, reportedly remarked that the Americans had done more in one night than his entire army would have done in six months. Exposed to the American batteries on Dorchester Heights and not strong enough to fight Washington's troops in other parts of Boston, the British army and fleet departed Boston on March 17, never again to occupy Massachusetts.

In 1802, Congress established a separate Corps of Engineers within the Army. At the same time, it established the U. S. Military Academy at West Point, the country's first — and for 20 years its only — engineering school. With the Army having the Nation's most readily available engineering talent, successive Congresses and administrations established a role for the Corps as an organization to carry out both military construction and works "of a civil nature."

Throughout the nineteenth century, the Corps supervised the construction of coastal fortifications, lighthouses, several early railroads, and many of the public buildings in Washington, D.C., and elsewhere. Meanwhile, the Corps of



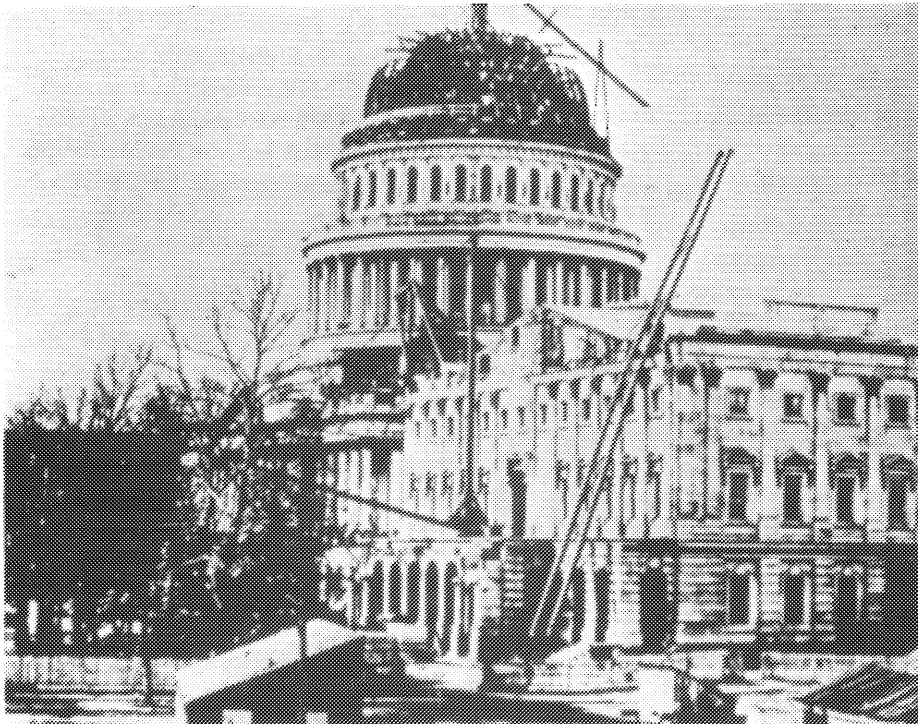
*Under the direction of Colonel Richard Gridley, American patriots worked diligently throughout the early morning hours of June 17, 1775, designing a stout earthwork fortification that helped protect American soldiers from British cannonade in the historic Battle of Bunker Hill.*

Topographical Engineers, which enjoyed a separate existence for 25 years (1838-1863), mapped much of the American West. Army Engineers served with distinction in war, with many Engineer officers rising to prominence during the Civil War.

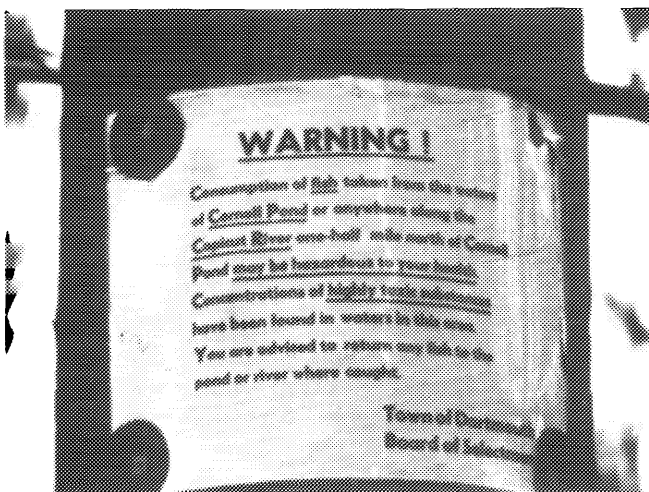
In its civil role, the Corps of Engineers became increasingly involved with river and harbor improvements, carrying out its first harbor and jetty work in the first quarter of the nineteenth century. The Corps' ongoing responsibility for federal river and harbor improvements dates from 1824, when Congress passed two acts authorizing the Corps to survey roads and canals and to remove obstacles on the Ohio and Mississippi rivers. Over the years since, the expertise gained by the Corps in navigation projects led succeeding adminis-

trations and Congresses to assign new water-related missions in such areas as flood control, shore and hurricane protection, hydropower, recreation, water supply and quality, and wetland protection.

Today's Corps of Engineers carries out missions in three broad areas: military construction and engineering support to military installations; reimbursable support to other federal agencies (such as the Environmental Protection Agency's "Superfund" program to clean up hazardous and toxic waste sites); and the Civil Works mission, centered around navigation, flood control and — under the Water Resources Development Acts of 1986, 1988, 1990 and 1992 — a growing role in environmental restoration.



*Army Engineers contributed to both planning and construction of our nation's capital. When the Capitol Building had to be reconstructed in 1857, the Corps built two new wings and redesigned the dome with cast and wrought iron. The completed dome, which weighed almost nine million pounds, was used by President Abraham Lincoln during the Civil War as a symbol of his intention to preserve the Union.*



*Cleaning chemical spills at hazardous waste sites is a team project between the Corps and the EPA. An area identified as a hazardous waste location was this site in Dartmouth, Massachusetts, near Cornell Pond and the Copicut River.*

# Authorization and Planning Process for Water Resources Projects

Corps of Engineers water resources activities are normally initiated by non-federal interests, authorized by Congress, funded by a combination of federal and non-federal sources, constructed by the Corps under the Civil Works Program and operated and maintained either by the Corps or by a non-federal sponsoring agency. New England Division has water resource responsibilities in all six New England states. The area assigned to New England Division contains 66,000 square miles, 13 million people, 6,100 miles of coastline, 13 major river basins and 11 deep draft commercial ports.

The Water Resources Development Act of 1986 made numerous changes in the way potential new water resources projects are studied, evaluated and funded. The major change is that the law now specifies greater non-federal cost sharing for most Corps water resources projects.

When local interests feel that a need exists for improved navigation, flood protection, or other water resources development, they may petition their representatives in Congress. A Congressional committee resolution or an act of Congress may then authorize the Corps of Engineers to investigate the problems and submit a report. Water resource studies are conducted in partnership with a non-federal sponsor, with the Corps and the sponsor jointly funding and managing the study.

Normally, the planning process for a water resource problem starts with a brief reconnaissance study to determine whether a project falls within the Corps' statutory authority and meets national priorities. Should that be the case, the Corps office where the project is located will carry out a full feasibility study to develop alternatives and select the best possible solution. This process normally includes public meetings to determine the views of local interests on the extent and type of improvements desired. The federal, state, and other agencies with interests in a project are partners in the planning process.

In making recommendations to Congress for project authorization, the Corps determines that the proposed project's benefits will exceed costs, its engineering design is sound, the project best serves the needs of the people concerned, and that it makes the wisest possible use of the natural resources involved and adequately protects the environment.

Once the Corps of Engineers completes its feasibility study, it submits a report, along with a final environmental impact statement, to higher authority for review and recommendations. After review and coordination with all interested federal agencies and the governors of affected states, the Chief of Engineers forwards the report and environmental statement to the Secretary of the Army, who obtains the views of the Office of Management and Budget before trans-

mitting these documents to Congress.

If Congress includes the project in an authorization bill, enactment of the bill constitutes authorization of the project. Before construction can get underway, however, both the federal government and the project sponsor must provide funds. Budget recommendations are based on evidence of support by the state and the ability and willingness of the non-federal sponsors to provide its share of the project cost.

Appropriation of money to build a particular project is usually included in the annual Energy and Water Development Appropriations Bill, which must be approved by both Houses of the Congress and signed by the President.

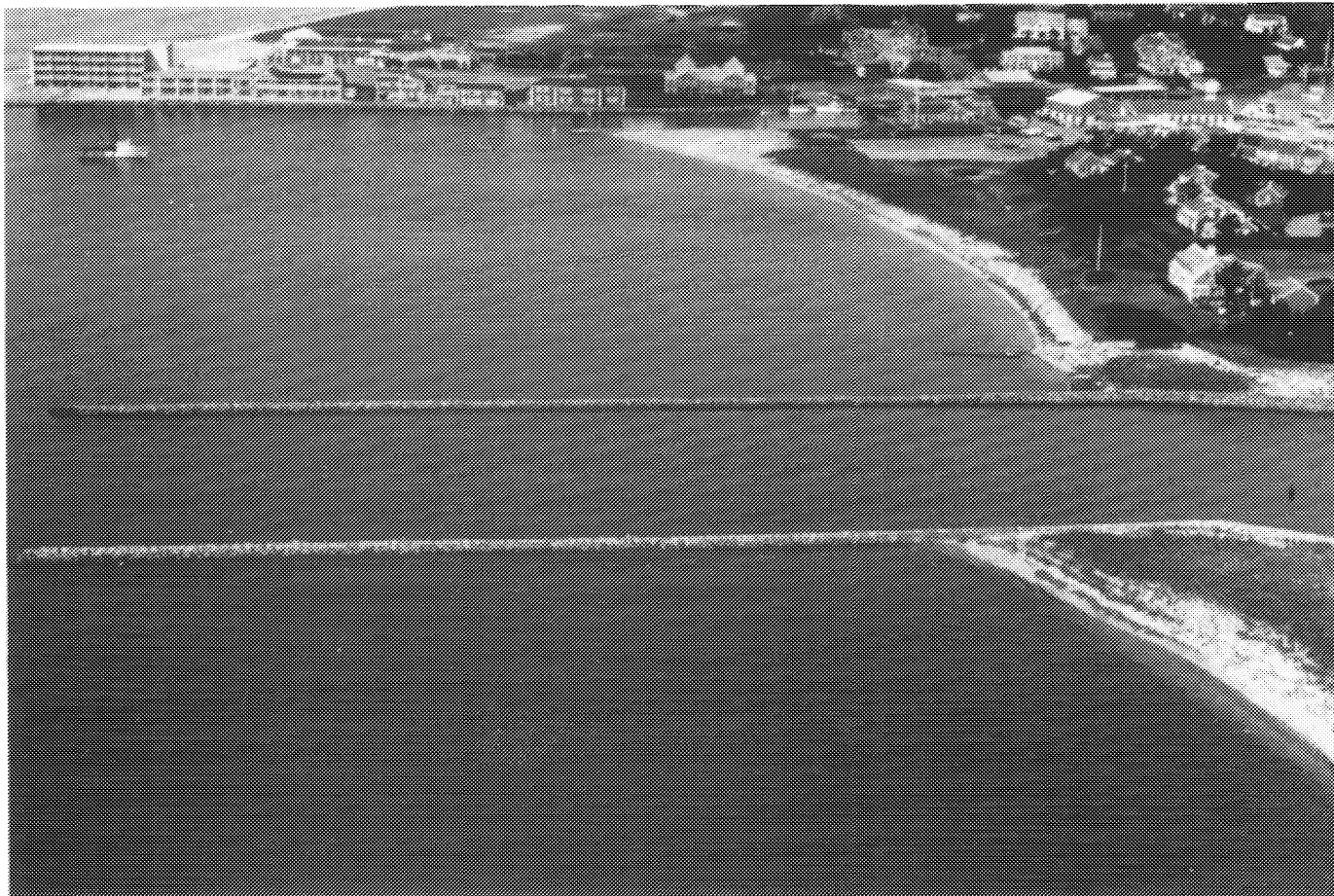
## Navigation

Rivers and waterways were the primary paths of commerce in the new country. They provided routes from western farms to eastern markets. They promised a new life to the seaboard emigre and financial reward for the Mississippi Valley merchant. Without its great rivers, the vast, thickly-forested region west of the Appalachians would have remained impenetrable to all but the most resourceful early pioneers.

Consequently, western politicians such as Henry Clay agitated for federal assistance to improve rivers. At the same time, the War of 1812 showed the importance of a reliable inland navigation system to national defense. There was, however, a question as to whether transportation was, under the Constitution, a legitimate federal activity. This question was resolved when the Supreme Court ruled that the Commerce Clause of the Constitution granted the federal government the authority not only to regulate navigation and commerce, but also to make necessary navigation improvements.

The system of harbors and waterways maintained by the Corps of Engineers remains one of the most important parts of the nation's transportation system. The Corps maintains the nation's waterways as a safe, reliable and economically efficient navigation system. The 12,000 miles of inland waterways maintained by the Corps carry one sixth of the nation's inter-city cargo. The importance of the Corps mission in maintaining depths at more than 500 harbors, meanwhile, is underscored by an estimated one job in five in the United States being dependent, to some extent, on the commerce handled by these ports.

River and Harbor work by the Corps of Engineers in New England was initiated by a congressional appropriation of \$20,000 on May 26, 1824, "to repair Plymouth Beach, in the Commonwealth of Massachusetts, and thereby prevent the harbor at that place from being destroyed." From that initial project at America's first permanent settlement, New England Division has completed 170 navigation projects, including 11 deep draft ports and adjacent waterways. The most visible of the Corps' navigation responsibilities in



*Jetties help provide safe channels for commercial and recreational vessels. The jetties at Saquatucket Harbor in Harwich, Massachusetts, also help prevent the buildup of sediment in the channel by directing and confining the tidal flow.*

New England is the Cape Cod Canal, which has been operated by the federal government since 1928. The canal is 17.5 miles long and is traversed by 19,000 vessels annually. In addition, its recreation features attract over 10 million annual visitors to the project.

## **Flood Control and Flood Plain Management**

Federal interest in flood control began in the alluvial valley of the Mississippi River in the 19th Century. As the relationship of flood control and navigation became apparent, Congress called on the Corps of Engineers to use its navigational expertise to devise solutions to flooding problems along the river.

After a series of disastrous floods affecting wide areas in the 1920's and 30's, Congress determined, in the Flood Control Act of 1936, that the federal government would participate in the solution of problems affecting the public interest that were too large or complex to be handled by states or

localities. Corps' authority for flood control work was thus extended to embrace the entire country. The Corps turns most of the flood control projects it builds over to non-federal authorities for operation and maintenance once construction is completed.

The purpose of flood control work is to prevent flood damage through regulation of the flow of water and other means. Prevention of flood-related damages can be accomplished with structural measures, such as reservoirs, levees, channels and floodwalls that modify the characteristics of floods; or non-structural measures, such as flood plain evacuation, floodproofing and floodway acquisition, that alter the way people use these areas and reduce the susceptibility of human activities to flood risk.

Corps' flood control reservoirs are often designed and built for multiple-purpose uses, such as municipal and industrial water supply, navigation, irrigation, hydroelectric power, conservation of fish and wildlife, and recreation.

The Corps fights the nation's flood problems not only by constructing and maintaining structures, but also by provid-

ing detailed technical information on flood hazards. Under the Flood Plain Management Services Program, the Corps provides, on request, flood hazard information, technical assistance and planning guidance to other federal agencies, states, local governments and private individuals. This information is designed to aid in planning for floods and regulation of flood plain areas, thus avoiding unwise development in flood-prone areas. Once community officials know the

floodprone areas in their communities and how often floods would be likely to occur, they can take necessary action to prevent or minimize damages to existing and new buildings and facilities, such as adopting and enforcing zoning ordinances, building codes and subdivision regulations. The Flood Plain Management Services Program also provides assistance to other federal and state agencies in the same manner.

# FLOODING IN NEW ENGLAND

New England has a long history of flooding. Through the years it has been hit with various storms that have caused millions of dollars in damages. Some of the more destructive hurricanes and floods the area has experienced since 1900 occurred in November 1927; March 1936; September 1938; September 1954; and August 1955. However, some of the highest flood levels in New England history occurred in April 1987 and gave many Corps dams the most serious test since they were built. Despite having six dams discharge excess water over emergency spillways because reservoir capacities had been reached, the 31 dams under the jurisdic-

tion of the Corps' New England Division held back billions of gallons of water that otherwise would have caused severe flooding downstream. The amount of water held back by these dams from this heavy rainfall was equivalent to a reservoir that could put the entire state of Rhode Island under more than one foot of water. Damages prevented by Corps flood control projects during the April 1987 storm amounted to \$462.6 million. Damages prevented by operation of hurricane barriers during a coastal storm in December 1992 and the flood control dams in the spring of 1993 totaled another \$104 million.

## 1927

*Floodwaters swirl around homes and trees in this Vermont community during the November 1927 flood. The storm claimed 21 lives and caused \$29.3 million in property damage.*



## 1936

*The rampaging waters of the North Nashua River ripped through the downtown area of Fitchburg, Massachusetts, during the March 1936 flood, taking with it homes, automobiles, and commercial and industrial property. Eleven lives were lost from this flood and damages were estimated at \$66.4 million.*





**1936**

*Waters from the Connecticut River surround the Hartford South Meadows Power Station (center) and cover much of Hartford, Connecticut, during the March 1936 flood. The spring floods of 1936 brought widespread disaster from Maine to Maryland and helped mold political and public opinion that culminated in the Flood Control Act of 1936, which recognized the proper involvement of the federal government in flood control. (Copyright 1936 The Hartford Courant.)*



**1938**

*The heavy rains of the September 1938 hurricane caused the Contoocook River to flood a section of East Jaffrey, New Hampshire. This storm, with its 121 m.p.h. gusts, took the lives of eight people in New England and caused damages of \$48.6 million (about \$823 million in today's dollars).*



**1954**

*Hurricane Carol, which struck the New England coast in August 1954, caused damages estimated at \$186 million (\$762 million in today's dollars). The storm achieved its greatest fury in a band stretching from New London, Connecticut, to the Cape Cod Canal. All that remains of the Rhode Island Yacht Club (above) in the Pawtuxet Neck section of Warwick, Rhode Island, is a cradle of piles after the structure was destroyed by Carol's high winds and waves. (Copyright 1954 The Providence Journal Company.)*



**1955**

*The Blackstone River overflows its banks and floods several businesses and homes in Pawtucket, Rhode Island, as a result of the heavy rains of Hurricane Diane in August 1955.*



## 1955

No natural disaster in New England history compares with the devastation caused by the sudden and torrential rainfall which accompanied Hurricane Diane in August 1955. The disaster killed 90 people and caused almost \$458 million (about \$2.03 billion in today's dollars) in property damage throughout the six-state region. In Connecticut alone, Diane's floodwaters killed 47 people and caused damages totalling about \$370 million (about \$1.5 billion in today's dollars). The rains of Hurricane Diane fell on ground already saturated by the rains of Hurricane Connie one week earlier.

One of the communities that sustained heavy damage was Winsted, Connecticut. The waters of the Mad River overflowed its banks and roared through Main Street, uprooting foundations and flooding homes and businesses. When the floodwaters receded, the devastation became apparent (right). Main Street had become a pile of rubble, cluttered with debris ripped from its understructure.

The storm also forced hundreds of New Englanders to evacuate their homes, including a Connecticut woman (above) who was dramatically rescued from ravaging floodwaters. (Copyright 1955 The Hartford Courant.)



Only two months later, as Connecticut was getting back on its feet, another severe flood disrupted rehabilitation measures and caused losses estimated at \$6.5 million. In response to these major floods, the Corps built several dams and local protection projects that, in a recurrence of the August 1955 flood today, would prevent damages of \$1.09 billion



**1955**

*As these photos from August 1955 demonstrate, floodwaters pose a powerful threat to property and lives. As the top photo shows, this Southbridge, Massachusetts, home was toppled when the floodwaters of the Quinebaug River weakened its foundation. Note the overturned automobile on the left; its only identifiable remains are its tires.*

*Floodwaters from the Blackstone River (above) roar through Webster Square in Worcester, Massachusetts.*

## Reservoir Control Center

As a flood situation develops, considerable judgment and experience are required to efficiently manage Corps dams and reservoirs. Weather conditions, reservoir storage capacities and the flood levels of rivers are important factors when operating dams that maximize the protection of downstream communities and minimize flood damage. The nature of New England weather requires the region's dams and reservoirs be professionally managed by trained engineers and hydrologists. These skilled professionals, using sophisticated communications equipment, form an integral part of the Corps' flood control efforts known as the Reservoir Control Center (RCC).

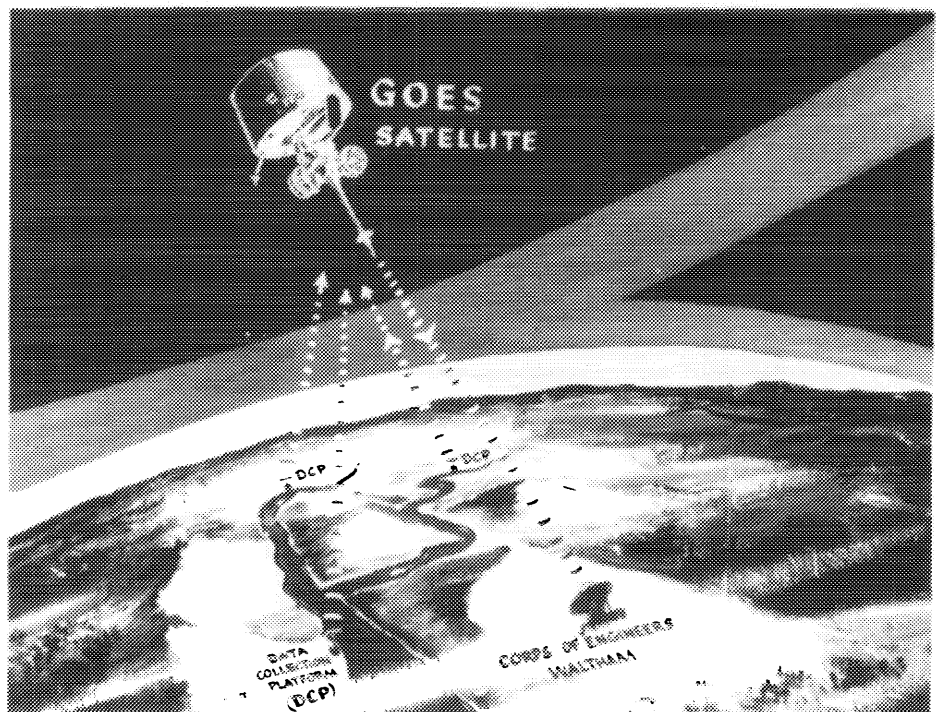
The RCC is located at the Corps' New England headquarters in Waltham, Massachusetts. From this site, Corps engineers closely monitor precipitation, river levels, and tidal levels in New England. The state-of-the-art communications equipment used by RCC personnel is complemented by the Geostationary Operational Environmental Satellite (GOES) System which serves as a communication link for the relay of hydrologic and meteorological data. Information from about 50 data collection platforms at key locations along rivers, streams and other bodies of water is relayed to a satellite, which transmits this data by radio signal to the RCC. Engineers then examine and analyze this hydrologic information for potential flood conditions and use this data to

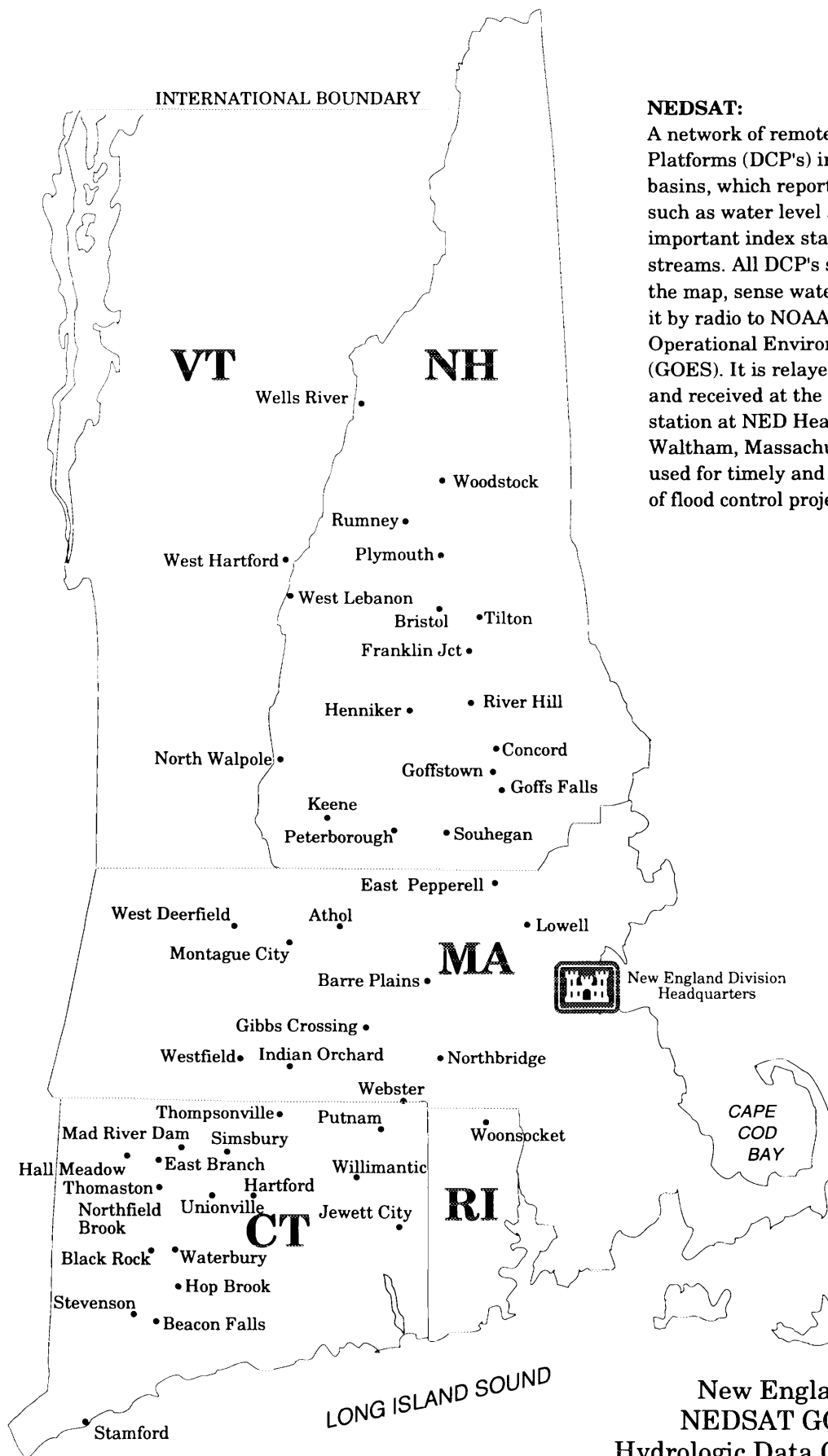
determine when to operate the flood control gates and when to release stored floodwaters from reservoirs once downstream flood conditions have receded. During flood emergency periods, additional information is obtained by telephone, teletype, and radio from field personnel and other agencies, such as the National Weather Service and the U.S. Geological Survey.

The Reservoir Control Center has helped minimize or prevent severe and damaging floods in many New England communities. The Corps is proud of its commitment to provide the public with improved flood protection through the professional management of its dams and hurricane protection barriers.

New England Division has been an innovative leader in the use of non-structural solutions for flooding problems. The Charles River Natural Valley Storage Project provides a novel approach to flood protection in parts of Boston and Cambridge by retaining flood flows on 8,100 acres of wetland areas acquired by the government at a cost of \$9 million. In Warwick, Rhode Island, flood-prone properties were acquired, removed or modified to withstand high water events with the federal government underwriting 80% of the cost. In these times of environmental concern and building restrictions, non-structural flood protection projects have the potential to protect life and property with minimal adverse environmental impacts.

*The GOES network, or the New England Division Satellite System (NEDSAT), plays a key role in helping the Corps reduce flood damage. About 50 data collection platforms (DCPs) are situated on various rivers and streams throughout five of the New England states (opposite page) where the Corps has dams and hurricane protection barriers. Hydrologic and meteorological data from these DCPs are relayed to a satellite stationed above the earth (right). The satellite then transmits this information by radio signal to the Corps' Reservoir Control Center in Waltham, Massachusetts. The data tell Corps' engineers when to open or close the floodgates of Corps' dams and hurricane protection barriers, thus limiting damage to communities downstream. The GOES system also provides the national weather maps displayed by local TV weathermen during their forecasts.*





### NEDSAT:

A network of remote Data Collection Platforms (DCP's) in five major river basins, which report hydrologic data such as water level and rainfall from important index stations on rivers and streams. All DCP's shown by dots on the map, sense water data and transmit it by radio to NOAA's Geostationary Operational Environmental Satellite (GOES). It is relayed back to Earth and received at the satellite ground station at NED Headquarters in Waltham, Massachusetts. There it is used for timely and effective operation of flood control projects.



New England Division  
NEDSAT GOES Satellite  
Hydrologic Data Collection Network

# SHORE AND HURRICANE PROTECTION

The Corps' work in shore protection began in 1930, when Congress directed it to study ways to reduce erosion along U.S. seacoasts and the Great Lakes. Hurricane protection work was added to the erosion control mission in 1955, when Congress directed it to conduct investigations along the Atlantic and Gulf coasts to identify problem areas and determine the feasibility of protection.

While each situation the Corps studies involves different considerations, engineers always consider engineering feasibility and economic efficiency along with the environmental and social impacts. Federal participation in a shore protection project varies, depending on shore ownership, use and type and frequency of benefits. If there is no public use or benefit, the Corps will not recommend federal participation. Once the project is complete, non-federal interests assume responsibility for its operation and maintenance. The New England Division has completed 38 shore protection projects in the region.

One shore protection method popular in seaside communities is beach nourishment — the periodic replenishment of sand along the shoreline to replace that lost to storms and erosion. Authorized nourishment projects usually have a nourishment period of 50 years. In addition, Section 145 of the Water Resources Development Act of 1976 authorizes placement of beach quality sand from Corps dredging projects on nearby beaches. Under Section 933 of the Water Resources Development Act of 1986, local sponsors pay the federal government 50 percent of the additional costs of this placement of sand.

New England Division has been a pioneer in the construction of hurricane protection barriers. NED has constructed and operates hurricane barriers in Stamford, CT, and New Bedford, MA. Additionally NED has constructed barriers in Providence, RI; Pawcatuck, CT; and New London, CT. The local communities have assumed responsibility for their operation and maintenance.



*This shore protection project at Oakland Beach in Warwick, Rhode Island, is a good example of how Corps' works help protect shores and restore beaches. Sand replenishment, which widened and restored the two beach areas on the far left and far right, slows the ocean's inland advance. The four groins maintain shore alignment by trapping and retaining sand. The stone revetment, in the center of the photograph between two groins, retards erosion.*

# HYDROPOWER

The Corps has played a significant role in meeting the nation's electric power generation needs by building and operating hydropower plants in connection with its large multiple-purpose dams. The Corps' involvement in hydropower generation began with the Rivers and Harbors Acts of 1890 and 1899, which required the Secretary of War and the Corps of Engineers to approve the sites and plans for all dams and to issue permits for their construction. The Rivers and Harbors Act of 1909 directed the Corps to consider various water uses, including water power, when submitting preliminary reports on potential projects.

The Corps continues to consider the potential for hydroelectric power development during the planning process for all water resources projects involving dams and reservoirs. In most instances today, it is non-federal interests who develop hydropower facilities at Corps projects without federal assistance. The Corps, however, can plan, build and operate hydropower projects when it is impractical for non-federal interests to do so. Today, the more than 20,000 megawatts of capacity at Corps-operated power plants provide approximately 30 percent of the nation's hydroelectric power, or three percent of its total electric energy supply.

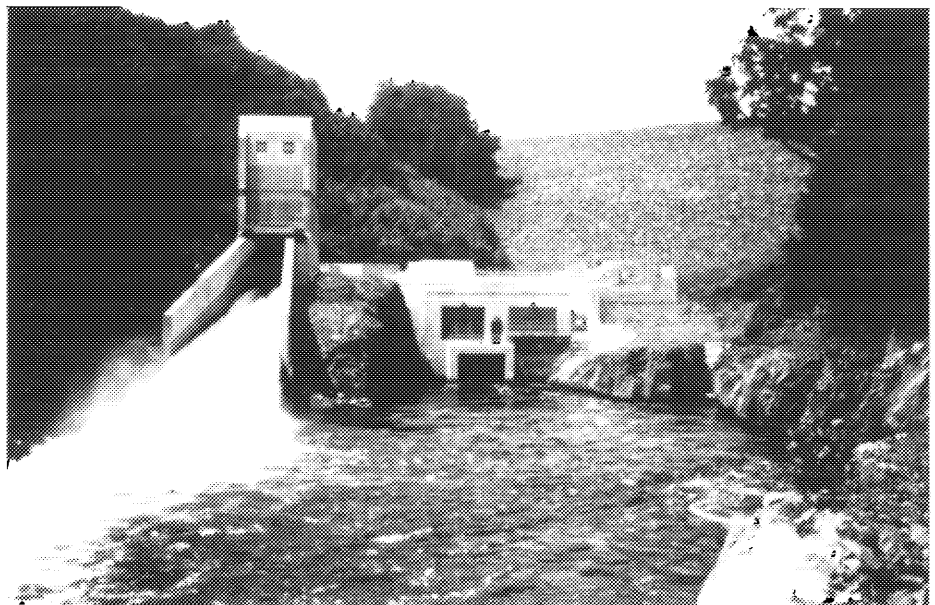
In New England, the Corps does not operate any hydroelectric power facilities, but there are eight hydroelectric power plants at Corps flood control dams which were constructed and are owned and operated by nonfederal interests. These plants are located in:

- *North Hartland, Vermont*, about 500 feet downstream of the North Hartland Lake Dam. This facility produces 4 megawatts of power. All power generated at this plant

is used by the Vermont Electric Cooperative or is sold to other utilities.

- *Quechee, Vermont*, 2.5 miles upstream of the North Hartland Lake Dam and within the reservoir area. Built on Corps land, this plant produces 1.8 megawatts. Power is sold to the Central Vermont Public Service Corporation.
- *Waterbury, Vermont*, at the base of the dam at Waterbury Reservoir. This facility generates approximately 5.5 megawatts of power, which is used by the Green Mountain Power Corporation.
- *Montpelier, Vermont*, approximately 200 feet downstream of the dam at Wrightsville Reservoir. The plant has the capacity to produce 1.2 megawatts of power, which is used by the Washington Electric Cooperative.
- *Franklin, New Hampshire*, on Salmon Brook. Built on Corps land within the Franklin Falls reservoir, this facility produces 0.2 megawatts of power. Power is sold to the Public Service Company of New Hampshire.
- *Bristol, New Hampshire*, on the Newfound River. This plant produces 1.5 megawatts and lies on private property but within the Franklin Falls reservoir area. Power is sold to the Public Service Company of New Hampshire.
- *Peterborough, New Hampshire*, on Verney Mills Dam at Edward MacDowell Lake. This facility began producing power in 1990. The power is sold to the Public Service Company of New Hampshire.

*Although the Corps does not presently operate any hydroelectric power plants in New England, there are eight hydropower plants located at Corps flood control projects in the region that are owned and operated by nonfederal interests. The North Hartland hydropower facility in North Hartland, Vermont, located 500 feet downstream of the Corps-operated North Hartland Lake Dam, is one such facility.*



- *Colebrook, Connecticut*, where six turbine generators are lowered by crane to a position in front of the intake conduits of Colebrook River Lake. Operated by the Metropolitan District Commission of Hartford, the 7.5 megawatts of power generated annually are sold to Connecticut Light & Power Company.
- *Hopkinton, New Hampshire, on the Contoocook River*. The Corps' Hopkinton Lake provides river flows up to 900 cfs or inflow if less through a forebay conduit to Consolidate Hydro Operations Inc's Hoague-Sprague Project. This facility produces 3.6 million kilowatt hours of power. The power is sold to Public Service Company of New Hampshire.

New England division is evaluating a prototype design for installation of a vertical axis hydro turbine (VAHT) which would harness the energies of the continual tidal currents at the Cape Cod Canal. If installed, the energy generated would offset the current electrical bill. This prototype has widespread repercussions as it does not require the costly superstructure of conventional submerged hydro turbines.

## Water Supply

Corps involvement in water supply dates back to 1853, when it began building the Washington Aqueduct, which provides water to the nation's capital city and some of its suburbs to this day.

Elsewhere in the nation, the Water Supply Act of 1958 authorized the Corps to provide additional storage in its reservoirs for municipal and industrial water supply at the request of local interests, who must agree to pay the cost. The Corps also supplies water for irrigation, under the Flood Control Act of 1944. This act provided that the Secretary of War, upon the recommendation of the Secretary of the

Interior, could allow use of Corps reservoirs for irrigation, provided that users agree to repay the government for the water.

## Environmental Quality

The Corps carries out the Civil Works Programs in consistency with many environmental laws, executive orders and regulations. Perhaps primary among these is the National Environmental Policy Act (NEPA) of 1969. This law requires federal agencies to study and consider the environmental impacts of their proposed actions. Consideration of the environmental impact of a Corps project begins in the early stages, and continues through design, construction and operation of the project. The Corps must also comply with these environmental laws and regulations in conducting its regulatory programs.

NEPA procedures ensure that public officials and private citizens may obtain and provide environmental information before federal agencies make decisions concerning the environment. In selecting alternative project designs, the Corps strives to choose options with minimum environmental impact.

The Water Resources Act of 1986 authorizes the Corps to propose modifications of its existing projects —many of them built before current environmental requirements were in effect for environmental improvement. Proposed modifications under this authority range from use of dredged material to create nesting sites for waterfowl to modification of water control structures to improve downstream water quality for fish.

In recent years the Corps of Engineers has planned and recommended environmental restoration actions at federal projects to restore environmental conditions.

# REGULATORY PROGRAMS

The Corps of Engineers regulates construction and other work in navigable waterways under Section 10 of the Rivers and Harbors Act of 1899, and has authority over the discharge of dredged or fill material into the "waters of the United States" (a term which includes wetlands and all other aquatic areas) under Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500, the "Clean Water Act"). Under these laws, those who seek to carry out such work must first receive a permit from the Corps.

The "Section 404" program is the principal way by which the federal government protects wetlands and other aquatic environments. The program's goal is to ensure protection of the aquatic environment while allowing for necessary economic development.

The permit evaluation process includes a public notice with a public comment period. Application for complex projects may also require a public hearing before the Corps makes a permit decision. In its evaluation of applications,

the Corps is required by law to consider all factors involving the public interest. These may include economics, environmental concerns, historical values, fish and wildlife, aesthetics, flood damage prevention, land use classifications, navigation, recreation, water supply, water quality, energy needs, food production and the general welfare of the public.

The Corps of Engineers has issued a number of nationwide general permits mostly for minor activities which have little or no environmental impact. Offices have also issued regional permits for certain types of minor work in specific areas and State Program General Permits in states with comprehensive wetland protection programs. These permits allow applicants to do work for which a state permit has been issued by reducing delays and paperwork for applicants and allowing the Corps to devote its resources to the most significant cases while maintaining the environmental safeguards of the Clean Water Act.



*Baker Cove in Groton, Connecticut, like many wetlands, supports numerous plant and animal species. Before building a proposed project in a given area, the Corps looks closely at the effects such a project may have on the environment and surrounding wetlands. The Corps considers all options, including those that preclude development, in finding a solution to a water resources problem.*

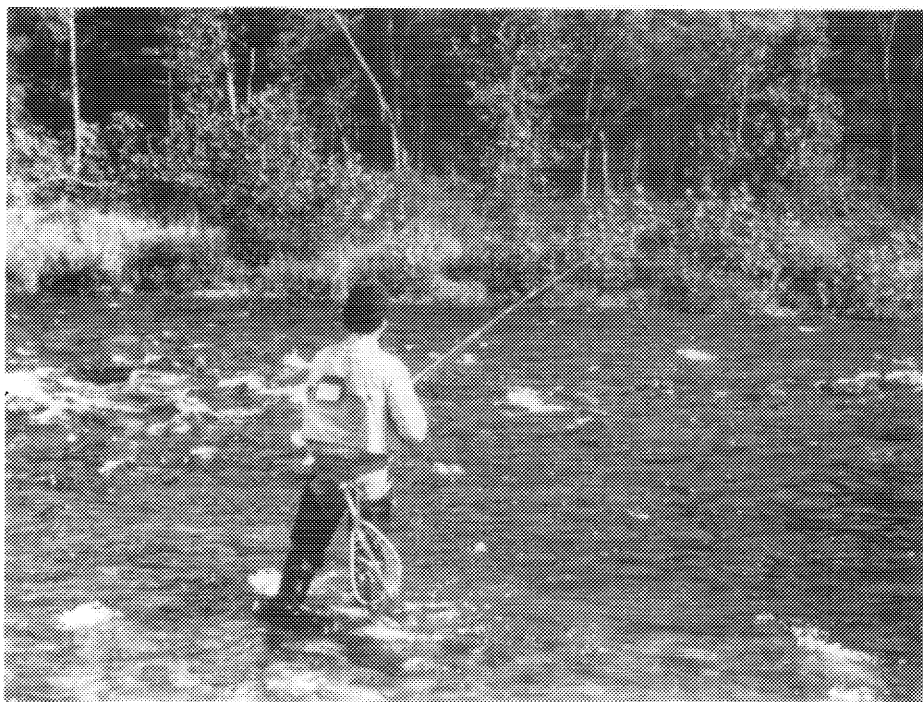
# RECREATION

The Flood Control Act of 1944, the Federal Water Project Recreation Act of 1965, and language in specific project authorization acts authorize the Corps to construct, maintain, and operate public park and recreational facilities at its projects, and to permit others to build, maintain, and operate such facilities. The water areas of Corps projects are open to public use for boating, fishing, and other recreational purposes.

The Corps of Engineers today is one of the federal government's largest providers of outdoor recreational opportunities, operating more than 2,000 sites at its lakes and other water resource projects. More than 600 million visits per year are recorded at these sites. State and local park authorities and private interests operate nearly 2,000 other areas at Corps projects.



*There are many recreational opportunities available at the 35 dams and reservoirs built by the Corps' New England Division such as snowmobiling at Blackwater Dam in Webster, New Hampshire (right); and fly fishing at Townshend Lake Dam in Townshend, Vermont (below).*



# EMERGENCY RESPONSE AND RECOVERY

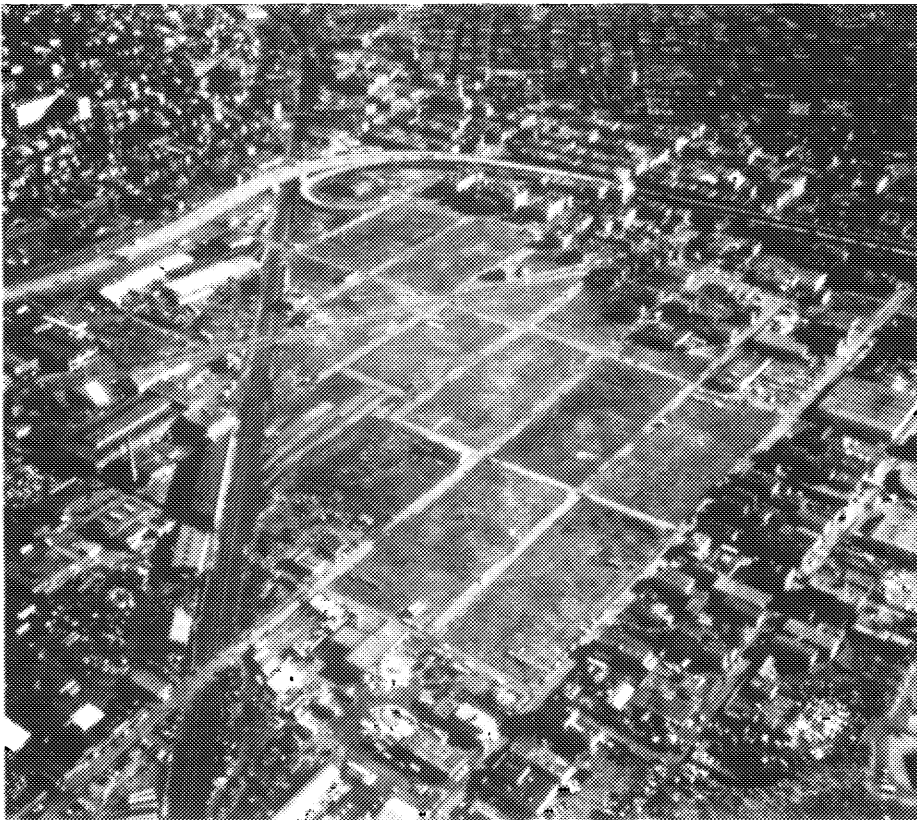
The Corps provides emergency response to natural disasters under Public Law 84-99 which covers flood control and coastal emergencies. It also provides emergency support to other agencies, particularly the Federal Emergency Management Agency (FEMA), under Public Law 93-288 (the Stafford Act), as amended.

Under PL 84-99 the Chief of Engineers, acting for the Secretary of the Army, is authorized to carry out disaster preparedness work, advance measures, emergency operations (e.g., flood fighting, rescue and emergency relief activities), rehabilitation of flood control works threatened or destroyed by flood, and protection or repair of federally authorized shore protection works threatened or damaged by coastal storms. This act also authorizes the Corps to provide emergency supplies of clean water in cases of drought or contaminated water supply. After the flooding has passed, the Corps provides temporary construction and repairs to essential pub-

lic utilities and facilities and emergency access for a 10-day period, at the request of the governor.

Under the Stafford Act and the Federal Disaster Response Plan, the Corps of Engineers has a standing mission assignment to provide public works and engineering support in response to a major disaster or catastrophic earthquake. Under this plan, the Corps will work directly with the state in providing temporary repair and construction of roads, bridges, and utilities, temporary shelter, debris removal and demolition, water supply, etc.

The Corps is one of the federal agencies tasked by FEMA to provide engineering, design, construction and contract management in support of recovery operations.



*The Corps provided disaster relief assistance to residents of Chelsea, Massachusetts, when fire destroyed 18 city blocks in October 1973.*

# DESCRIPTION OF PROJECTS

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# River Basins

Flooding is caused by a combination of many factors related to the underlying river basin. Corps' flood damage reduction projects, such as dams and local protection projects, are designed and constructed as part of an overall plan to limit flooding in a particular river basin.

There are 19 principal river basins that lie entirely or partially in New England. Of this number, three lie in parts of Vermont — the Connecticut River Basin, Hudson River Basin, and Lake Champlain Basin\*. All three basins have Corps' flood damage reduction projects within their drainage areas. Projects in the Connecticut River Basin were constructed by the Corps' New England Division; projects in the Hudson River and Lake Champlain Basins were constructed by the Corps' New York District. In terms of area, Vermont is

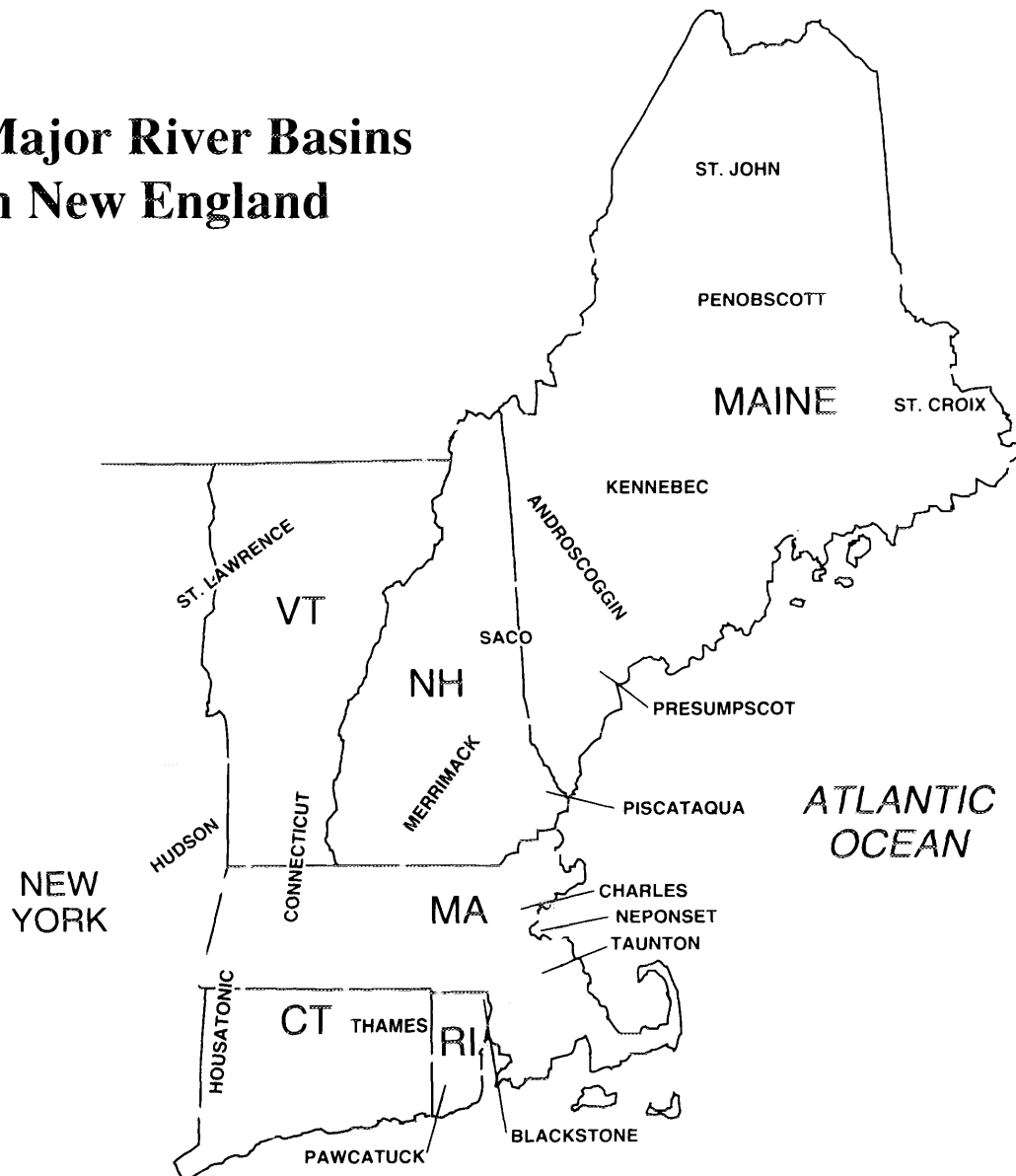
New England's second largest state (behind Maine's 33,215) with 9,609 square miles.

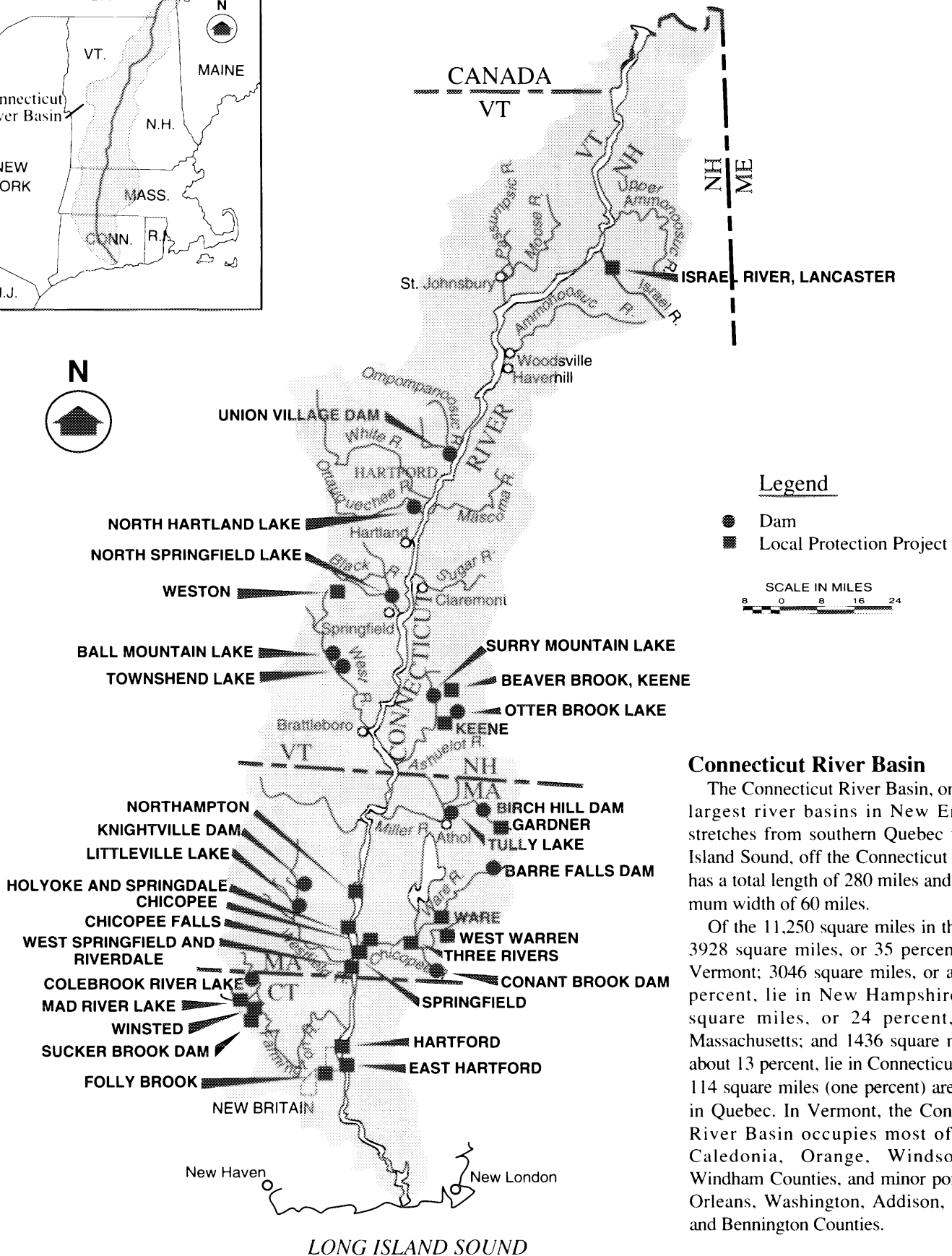
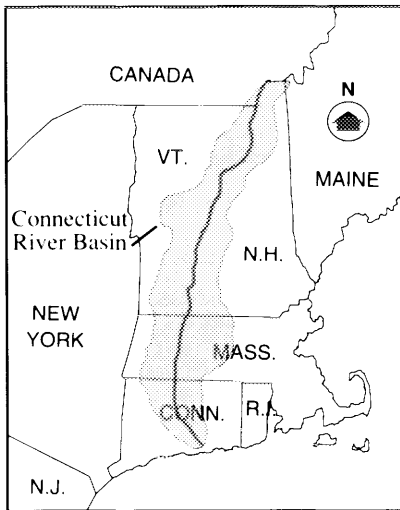
The following pages show where the three river basins lie in the state and the location of Corps' flood damage reduction projects within each basin.

\* *The Lake Champlain Basin is part of the much larger St. Lawrence River System, which is comprised of:*

- *The five Great Lakes (Superior, Michigan, Huron, Erie, and Ontario) and their respective basins;*
- *Waterways connecting to the lakes; and*
- *The St. Lawrence River and its tributaries. For the purposes of this report, only the Lake Champlain Basin is discussed because of its hydrological impact on Vermont.*

## Major River Basins in New England

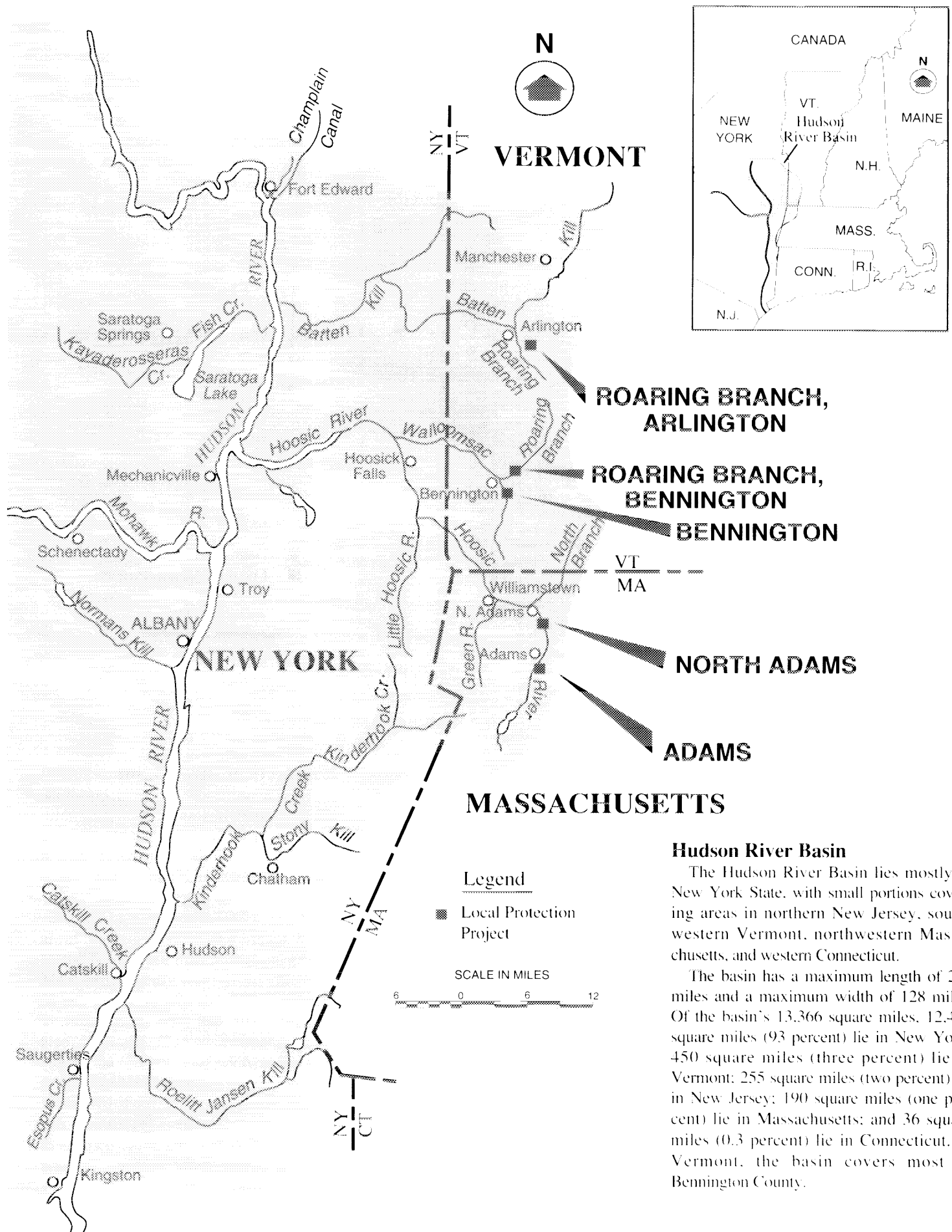


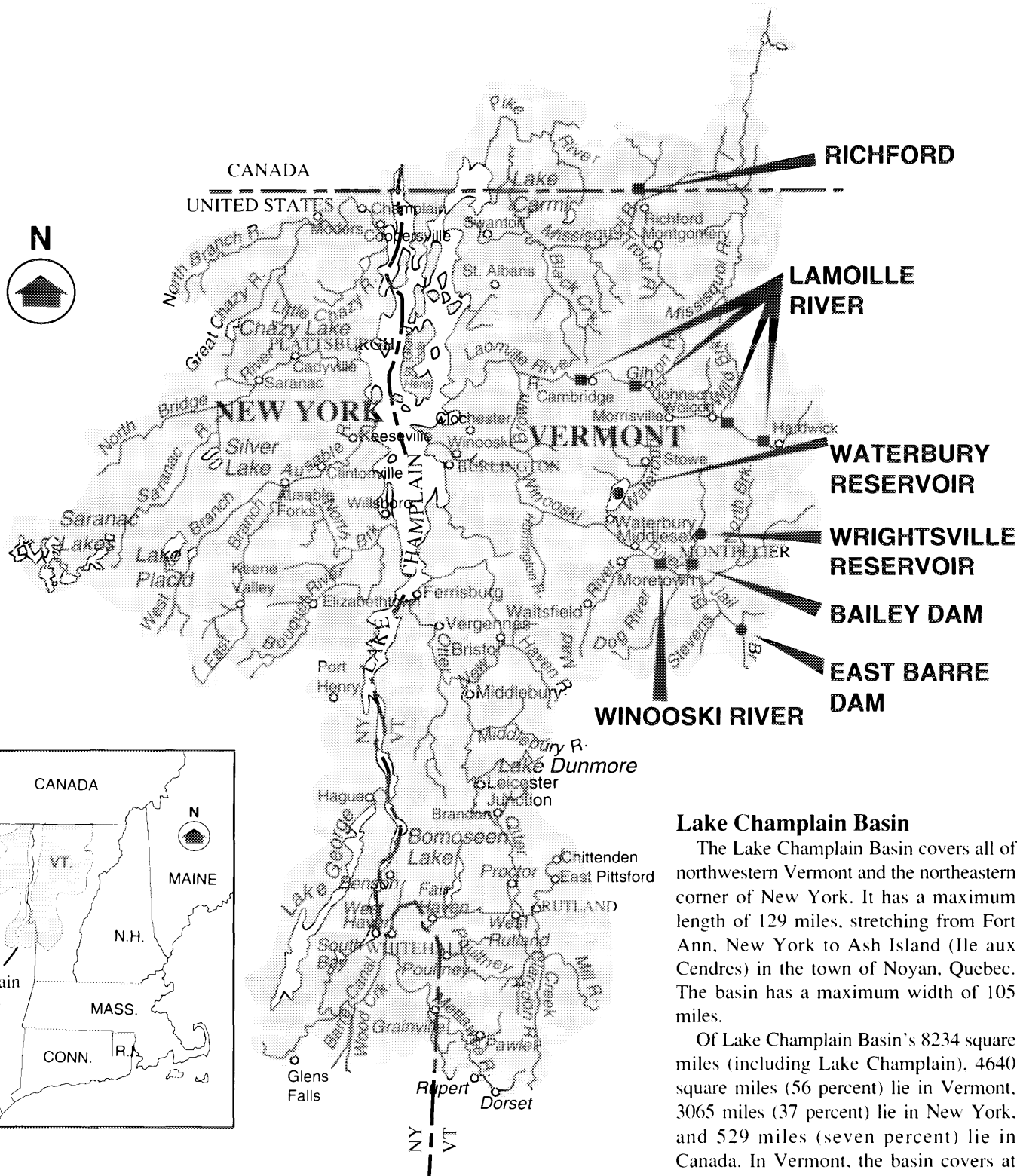


### Connecticut River Basin

The Connecticut River Basin, one of the largest river basins in New England, stretches from southern Quebec to Long Island Sound, off the Connecticut coast. It has a total length of 280 miles and a maximum width of 60 miles.

Of the 11,250 square miles in the basin, 3,928 square miles, or 35 percent, lie in Vermont; 3,046 square miles, or about 27 percent, lie in New Hampshire; 2,726 square miles, or 24 percent, lie in Massachusetts; and 1,436 square miles, or about 13 percent, lie in Connecticut. About 114 square miles (one percent) are located in Quebec. In Vermont, the Connecticut River Basin occupies most of Essex, Caledonia, Orange, Windsor, and Windham Counties, and minor portions of Orleans, Washington, Addison, Rutland and Bennington Counties.





### Lake Champlain Basin

The Lake Champlain Basin covers all of northwestern Vermont and the northeastern corner of New York. It has a maximum length of 129 miles, stretching from Fort Ann, New York to Ash Island (Île aux Cendres) in the town of Noyan, Quebec. The basin has a maximum width of 105 miles.

Of Lake Champlain Basin's 8234 square miles (including Lake Champlain), 4640 square miles (56 percent) lie in Vermont, 3065 miles (37 percent) lie in New York, and 529 miles (seven percent) lie in Canada. In Vermont, the basin covers at least part of 11 of the state's 14 counties. These include all of Grand Isle, Chittenden, Franklin, Lamoille, and Washington Counties; most of Addison and Rutland Counties; the eastern third of Orleans County; northwestern Orange County; a small section of western Caledonia County; and the northern tip of Bennington County.

# Flood Damage Reduction

The U.S. Army Corps of Engineers has constructed 17 flood damage reduction projects in Vermont that significantly reduce flooding and associated damages.

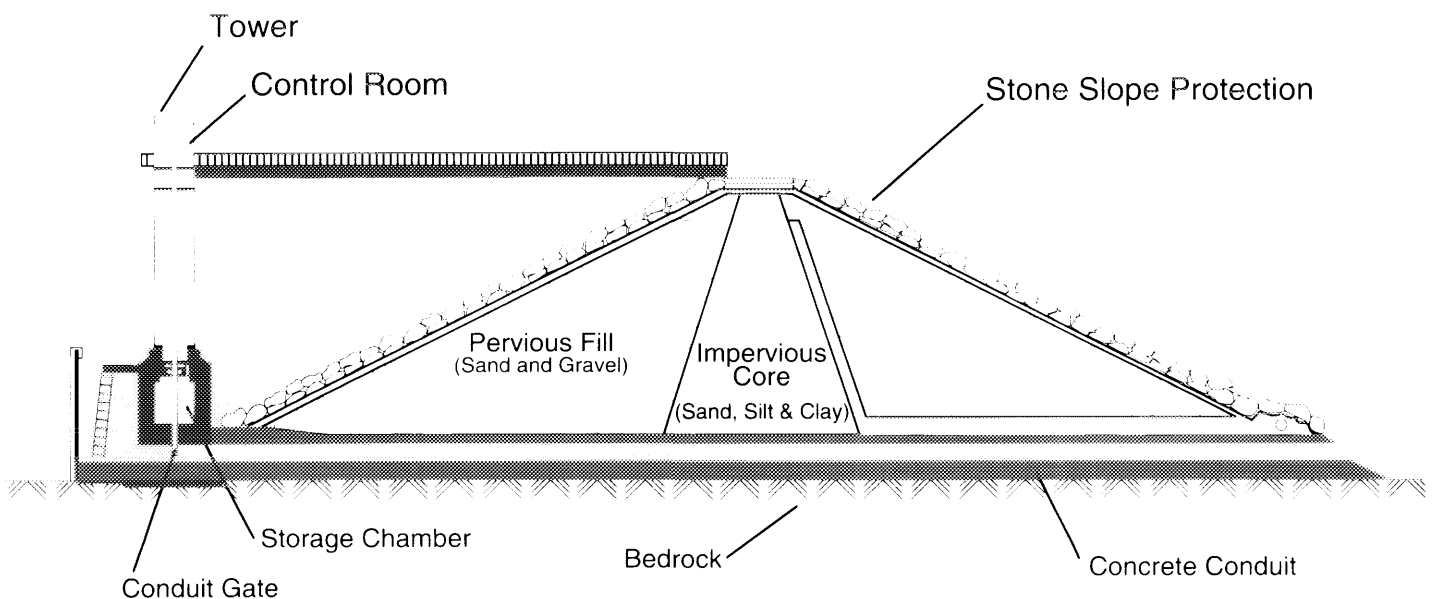
The eight Corps-built dams protect wide regions of the state. Costing an approximate \$48.9 million to construct, they have prevented flood damages estimated at \$322.1 million while also offering the public a variety of recreational opportunities and enhancing the environment.

The Corps has also completed nine other flood damage reduction projects in Vermont at a cost of approximately \$3.1 million. These works are more commonly referred to as local

protection projects because they provide flood protection to specific communities rather than wide areas of a state. In Vermont, these projects have prevented an estimated \$6.2 million in flood damages. Local protection projects are operated and maintained by the respective municipalities.

The following pages give a brief history and description of the flood damage reduction projects constructed by the Corps in Vermont.

*Note: Figures for damages prevented by each flood control project may be found on the insert at the front of the book.*



**TYPICAL CROSS SECTION OF AN EARTHFILL DAM**

# FLOOD DAMAGE REDUCTION PROJECTS

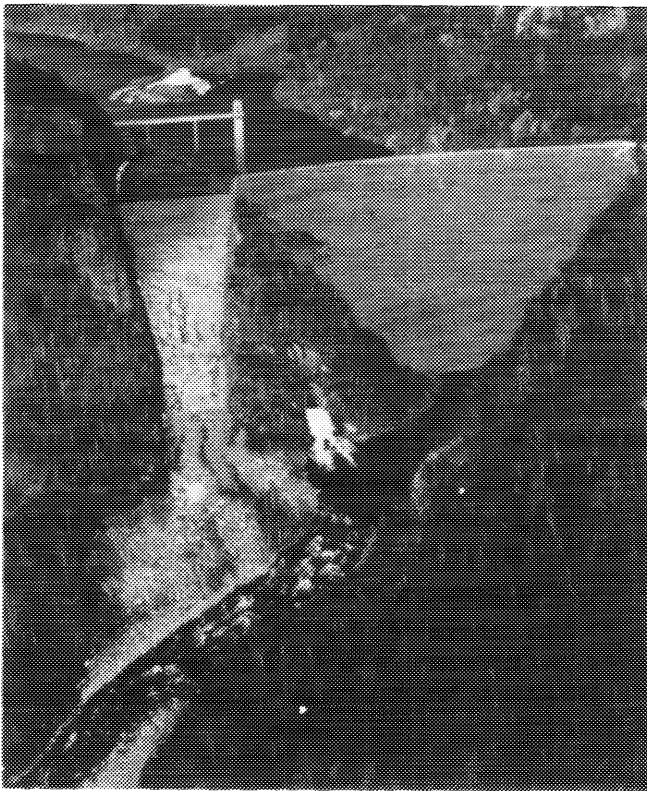
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## **Dams and Reservoirs**

Ball Mountain Lake in Jamaica  
East Barre Dam in Barre  
North Hartland Lake in Hartland  
North Springfield Lake in Springfield  
Townshend Lake in Townshend  
Union Village Dam in Thetford  
Waterbury Reservoir in Waterbury  
Wrightsville Reservoir in Montpelier

## **Local Protection Projects**

Bailey Dam, Montpelier  
Bennington  
Hartford  
Lamoille River, Cambridge and Hardwick  
Mill Brook, Brownsville  
Richford  
Roaring Branch, Arlington  
Roaring Branch, Bennington  
Saxton's River, Rockingham  
Weston  
Winooski River, Middlesex and Montpelier



*Ball Mountain Lake*

## Ball Mountain Lake

The dam at Ball Mountain Lake in Jamaica is located on the West River at the eastern edge of the Green Mountain National Forest. From Brattleboro, visitors can reach the dam by heading north on Route 30 to Jamaica.

The reservoir provides flood protection to the downstream communities in the West River Valley, including Jamaica, Townshend (particularly the West Townshend and Harmonyville sections), and Dummerston. In conjunction with other reservoirs in the Connecticut River Basin, Ball Mountain Lake also reduces flood stages on the Connecticut River.

Construction of the dam began in May 1957 and was completed in October 1961 at a cost of \$11 million. The project features an earthfill dam with stone slope protection 915 feet long and 265 feet high; a gated, 864-foot-long circular concrete conduit with a diameter of 13 feet six inches; and a chute spillway cut in rock with a 235-foot-long concrete weir. The weir's crest elevation is 35 feet lower than the top of the dam. About 1.5 miles of roads, 0.5 mile of utilities, and a 10-grave cemetery were relocated. Construction of the recreational facilities at the reservoir began in June 1975 and were completed in June 1977.

Ball Mountain Lake has a permanent pool of 20 acres with a stage of 25 feet. From mid-May to mid-October, this pool is enlarged to 75 acres, a stage of 65 feet, to increase the seasonal

recreational opportunities and improve reservoir aesthetics. The flood storage area of the project totals 810 acres and extends 6.5 miles upstream through Londonderry. The project and associated lands cover 1,227 acres. Ball Mountain Lake can store up to 17.8 billion gallons of water for flood control purposes. This is equivalent to 5.9 inches of water covering its drainage area of 172 square miles.

Surrounding the project is the unspoiled and highly scenic West River Valley. The land and water in both the reservoir area and the adjacent Winhall Brook Campground are well suited for a variety of leisurely pursuits. The reservoir area at Ball Mountain Lake offers five picnic tables, including two on the overlook, and three fireplaces. Sanitary facilities are provided. Fishermen will enjoy stocked rainbow, brown, and brook trout, and self-sustaining smallmouth bass. There is in-season hunting for native deer, bear, rabbit, partridge, woodcock, squirrel, raccoon, ruffed grouse, and duck.

Located within the project lands of Ball Mountain Lake is the Winhall Brook Camping Area in Londonderry. Situated about nine miles north of Ball Mountain Lake on Route 100, the Winhall Brook Camping Area offers a variety of recreational pursuits. There are 109 campsites, many of them streamside and each with its own picnic table and fireplace ring. Hikers and snowmobilers enjoy the .5-mile-long marked trail around the camping area and the two miles of old abandoned railroad bed within the campground. There is an open field for softball and other sporting activities, as well as a volleyball playing area situated about 1/4 mile from the campground's entrance. The campground features hot showers, sanitary facilities, a trailer dump station, and drinking water. Weekend evening campfire programs and guided walks are offered. The West River presents an excellent challenge to fly fishermen and has outstanding caddisfly hatches. The West River also features state-stocked brown trout, native brook, and stocked Atlantic salmon, which is part of the Atlantic Salmon Restoration Program. The Winhall River offers fishing for state-stocked brown, brook, and rainbow trout. In-season hunting is available for the same species listed above in the reservoir area.

The section of the West River between Ball Mountain Lake and Townshend Lake has developed into one of the major centers of whitewater canoeing and kayaking in the East. The Corps makes controlled water releases from both dams in the spring, generally on the last weekend in late April. There are also controlled releases from both dams on a weekend in mid-September.

The 1986 Water Resources Development Act passed by Congress authorized the Corps to design, construct, and operate facilities that will enable upstream migrant adult Atlantic salmon to bypass the dams at Ball Mountain and Townshend Lakes. The law also authorized the Corps to provide the necessary facilities for the downstream passage of juvenile salmon. A \$925,000 fish passage project on the West River was completed by the Corps in January 1993 encompassing both Ball Mountain and Townshend lake dams. The facility at Townshend Lake consists of the construction of a fish trap to collect upstream migrant salmon which would then be trans-

ported via tank truck above the dam to release points at both Ball Mountain and Townshend lakes. Modifications were made at both Ball Mountain and Townshend lakes to allow for downstream migration of juvenile salmon as well.

The normal pool elevation of feet at Ball Mountain Lake will be reduced to 25 feet each year to attract the juvenile salmon (April thru mid-June), and one of the three manual flood gate controls has been replaced with an automated gate operator which will automatically regulate outflows to assure that the 25-foot pool elevation will be maintained during normal flows.

At Townshend Dam, a splash weir was constructed within the intake weir structure upstream of the center flood control gate to form a splash pool to protect juvenile salmon from injury due to the 20-foot drop to the inlet weir floor. A one-foot V-notch was cut into the inlet weir to allow the juvenile salmon to enter the outlet during low flow periods. It is estimated that 75,000 to 80,000 juvenile salmon will pass downstream annually on their migration to the ocean.

## East Barre Dam

The East Barre Dam in Barre is located on the Jail Branch of the Winooski River. From Barre, the dam can be reached by travelling two miles east on Route 302. The project provides flood protection primarily to Barre and Montpelier. In conjunction with Waterbury Reservoir and Wrightsville Reservoir, the project reduces flood damage to other communities downstream on the Winooski River, including Waterbury.

Construction of the dam began in July 1933 and was completed in November 1935. The project consists of an earthfill dam with stone slope protection 1,460 feet long and 65 feet high; a 313-foot-long concrete rectangular conduit four feet wide and seven feet high; and a spillway with a 174-foot-long concrete ogee weir. The weir's crest elevation is 20 feet lower than the top of the dam. The East Barre Dam was one of four flood damage reduction projects constructed in Vermont by the Civilian Conservation Corps in the 1930s. Construction was overseen by the Corps' North Atlantic Division. Because of accounting procedures, the construction costs of East Barre Dam were not calculated separately, but instead lumped together with the construction costs of Waterbury Reservoir, Wrightsville Reservoir, and the Winooski River Local Protection Project. The construction costs of these four projects totalled \$13.7 million. Following completion, East Barre Dam was turned over to the State of Vermont for operation and maintenance.

The present day dimensions of the dam are the result of two major modifications. The first modification, which began in December 1956, allows a greater amount of water to pass through the spillway, increasing the dam's structural integrity. The work included raising the dam's elevation by 10 feet, lengthening it 420 feet, enlarging the discharge capacity of the conduit, constructing new spillway approach and discharge channels, and constructing a new weir. These improvements,

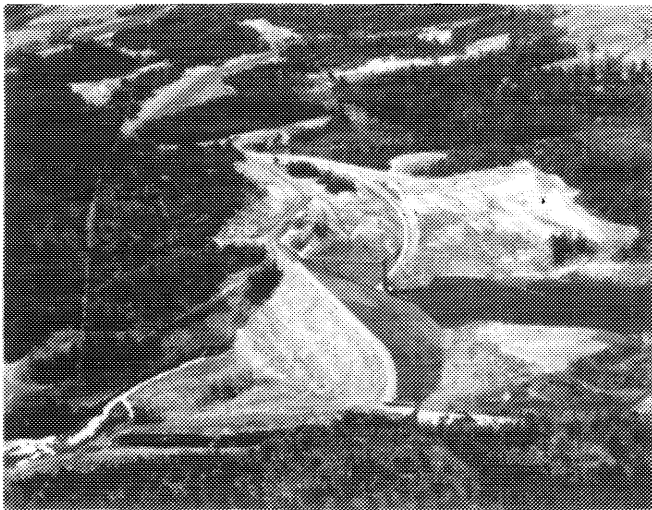


*East Barre Dam*

completed in August 1960, required the relocation of 2,917 feet of U.S. Route 302, 1,875 feet of Route 110, and power and telephone lines. The second modification began in June 1959 and involved the construction of a new outlet stilling basin, which was necessitated by the increased conduit discharge capacity. This work was completed in May 1960 at a cost of \$3 million. A third modification to East Barre Dam, accomplished between June-November 1985, included the reconstruction of the stilling basin. This modification cost \$309,900.

There is no lake at East Barre Dam. The flood storage area of the project, which is normally empty and utilized only to store floodwaters, totals 675 acres and extends 2.5 miles upstream through Orange and Washington. The project and associated lands cover 374 acres. East Barre Dam can store up to 3.9 billion gallons of water for flood control purposes. This is equivalent to 5.8 inches of water covering its drainage area of 38.7 square miles.

Although there are no designated trails, project lands are used for snowmobiling. Native brook trout and self-sustaining brown trout can be found in Jail Branch, which runs through the project. There is in-season hunting for woodcock.



*North Hartland Lake*

## North Hartland Lake

The dam at North Hartland Lake in Hartland is located on the Ottauquechee River, 1.5 miles above the confluence of the Ottauquechee and Connecticut Rivers. From White River Junction, the dam is five miles south on U.S. Route 5.

The project provides flood protection to downstream communities on the Connecticut River, including Hartland, Windsor, Weathersfield, Springfield, and Rockingham, and the New Hampshire communities of Plainfield, Cornish, Claremont, Charlestown, and Walpole. In conjunction with other reservoirs in the Connecticut River Basin, North Hartland Lake also reduces the Connecticut River's flood stages in Connecticut and Massachusetts.

Construction began in June 1958 and was completed in June 1961 at a cost of \$7.3 million. The project consists of an earthfill dam with stone slope protection 1,640 feet long and 185 feet high; a 743-foot-long gated concrete horseshoe conduit under the dam with a diameter of 14 feet four inches; a 2,110-foot-long dike with stone slope protection having a maximum height of 52 feet; a 476-foot-long gated concrete circular conduit under the dike with a diameter of three feet; and an L-shaped spillway cut in rock with a 465-foot-long concrete ogee weir. The weir's crest elevation is 25.5 feet lower than the top of the dam. Relocations included telephone and power lines and approximately 2.2 miles of highway.

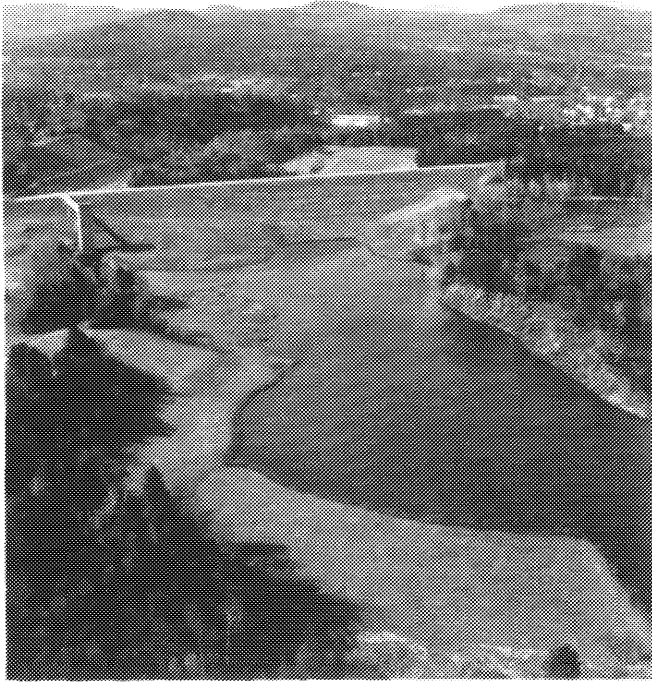
North Hartland Lake has a permanent pool of 215 acres with a depth of 35 feet. The flood storage area of the project totals 1,100 acres and extends 5.5 miles upstream through Hartford. The project and associated lands (including Quechee Gorge State Park) cover 1,711 acres. North Hartland Lake can store up to 23.2 billion gallons of water for flood control purposes. This is equivalent to 6.1 inches of water covering its drainage area of 220 square miles.

The reservoir area offers a wide variety of leisurely pursuits. There are 33 picnic tables with 11 fireplace grills and nine brick fireplaces; two picnic shelters; swimming on an approximately 100-foot-long beach; boating for power and non-power boats; and a boat ramp. There is an approximately one-mile long marked hiking trail used also for snowmobiling and cross-country skiing. The recreation area offers an open field for ball playing, horseshoe pits, a volleyball post and net, sanitary facilities, and drinking water. Fishermen will enjoy state-stocked rainbow trout in the reservoir, as well as perch, and brown bullhead. Two miles of stream fishing from feeder brooks and the Ottauquechee River are available within the reservoir area. The feeder streams provide self-sustaining brook trout, and the Ottauquechee River offers state-stocked rainbow trout and self-sustaining brown and brook trout in a wide range of fishing conditions, ranging from heavy water to placid pools. Hunters will find wild turkey, deer, partridge, fox, woodcock, raccoon, ruffed grouse, and squirrel.

About 2.5 miles upstream of the dam (approximately 5.5 miles by car), the Ottauquechee River flows through a sheer-faced, 163-foot-deep valley known as Quechee Gorge, one of the most beautiful natural spectacles in the northeastern United States. An overlook area on U.S. Route 4 provides splendid views. Quechee Gorge State Park, operated by the Vermont Department of Forests, Parks, and Recreation, is located at the edge of the Gorge (The park is situated on Corps-owned land that is part of the North Hartland Lake reservoir area). Quechee Gorge State Park offers 48 campsites and six lean-tos, each with its own picnic table and fireplace grill. There are also a total of 20 picnic tables and 11 fireplace grills along the sides of the gorge for non-campers. Boating (non-power boats only) is permitted on Dewey's Mills Pond. The park has three marked hiking trails with distances of two miles, one-half mile, and 1/4 mile, as well as marked cross-country skiing and snowmobile trails (the hiking trails can also be used for cross-country skiing and snowmobiling). Quechee Gorge State Park offers an open field for ball playing; a small playground; hot showers; drinking water; and sanitary facilities. The state stocks brown and rainbow trout on the Ottauquechee River upstream of Quechee Gorge, and largemouth bass can be caught in Dewey's Mills Pond. Ice fishing is permitted. Hunters will find deer, partridge, and ruffed grouse in season.

From North Hartland Lake, it is a short drive to Quechee Gorge State Park. When leaving the dam, turn right on Clay Hill Road and drive 4.4 miles to U.S. Route 4. Turn right on U.S. Route 4 (east). It is 1.1 mile to the park.

There are two hydroelectric power plants within the reservoir area of North Hartland Lake that are owned and operated by private interests. One plant, the North Hartland Hydropower Project, is situated about 500 feet downstream of the dam at North Hartland Lake. This facility produces four megawatts of power, which is used by the Vermont Electric Cooperative or sold to other utilities. The second plant, Dewey's Mills Hydroelectric Power Generating Station, is situated at Dewey's Mills Dam on the Ottauquechee River in



*North Springfield Lake*

Hartford, approximately 2.5 miles upstream of the dam at North Hartland Lake and immediately upstream of Quechee Gorge. This facility, located at the site of the former Dewey's Textile Mill, produces 1.8 megawatts of power, which is sold to the Central Vermont Public Service Corporation.

## North Springfield Lake

The dam at North Springfield Lake in Springfield is located on the Black River, about 8.5 miles upstream of the confluence of the Black and Connecticut rivers. From Springfield, visitors can reach the dam by travelling north on Route 106 to Reservoir Road.

The project provides flood protection to Springfield, and in conjunction with other Corps dams and reservoirs in the Connecticut River Basin, reduces flood damages to Connecticut River communities situated downstream.

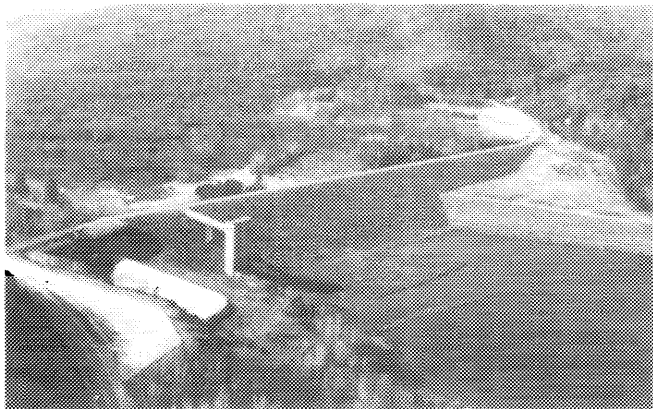
Construction of North Springfield Lake began in May 1958 and was completed in November 1960 at a cost of \$6.8 million. The project consists of an earthfill dam with stone slope protection 2,940 feet long and 120 feet high; a 659-foot-long gated concrete horseshoe conduit with a diameter of 12 feet nine inches; and a spillway cut in rock with a 384-foot-long concrete ogee weir. The weir's crest elevation is 24.5 feet lower than the top of the dam. Approximately three miles upstream of the dam is Stoughton Pond, situated on the North Branch of the Black River in Weathersfield. The pond is impounded by an embankment, which was the site of Route 22 before North Springfield Lake was built. The embankment is 900 feet long and was raised to a height of 75 feet by the

Corps. Under this embankment the Corps constructed a 300-foot-long circular metal conduit with a diameter of eight feet, and an earthen spillway with a 200-foot-long broad-crested weir. The weir's crest elevation is two feet lower than the top of the embankment. The work involved the construction of 3.8 miles of relocated roads and highway, and the relocation of a 150-grave cemetery.

North Springfield Lake has a permanent pool of 100 acres with a depth of about 15 feet (Stoughton Pond has a permanent pool of about 65 acres with a maximum depth of about 20 feet). The flood storage area of the project totals 1,200 acres and extends 5.4 miles upstream through Weathersfield. The project and associated lands cover 1,755 acres. North Springfield Lake can store up to 16.7 billion gallons of water for flood control purposes. This is equivalent to 5.9 inches of water covering its drainage area of 158 square miles.

The reservoir area of North Springfield Lake offers a myriad of recreational opportunities. It includes two recreation areas: the Stoughton Pond Recreation Area, located adjacent to Stoughton Pond, and the recreation area behind the main dam. The Stoughton Pond Recreation Area offers 30 picnic tables and 20 fireplace grills; a picnic shelter; swimming on a 200-foot-long beach; a 1/3-mile-long marked hiking trail; a change house; drinking water; and sanitary facilities. The recreation area behind the main dam offers an eight-mile-long marked cross-country skiing/snowmobile trail and several miles of gravel road suitable for hiking. About 70 acres of the recreation area behind the main dam is leased to the Audubon Society, which has a marked hiking trail system known as the Springweather Nature Area covering 55 acres. Boating (power boats limited to 5 mph) is permitted throughout the North Springfield Lake reservoir area, and boat ramps are available in both recreation areas. Also popular at North Springfield Lake are horseback riding, model airplane flying, and snowshoeing. History buffs will enjoy an 18th century military road (Crown Point Road) that passes through the project. Either Reservoir Road or Route 106 will get visitors between the two recreation areas.

North Springfield Lake has developed into one of the best largemouth bass lakes in southeastern Vermont. Smallmouth bass, horned pout, sunfish, and dace are also native to the 100-acre lake. Rainbow trout are stocked by the state behind Stoughton Pond Dam. There is also fishing for native brook trout throughout the project's five miles of streams. In-season hunting and trapping are permitted throughout the reservoir area for native deer, fox, duck, woodcock, squirrel, grouse, and raccoon.



*Townshend Lake*

## Townshend Lake

Townshend Lake in Townshend is located on the West River, about 19.5 miles upstream of the confluence of the West and Connecticut rivers. From Brattleboro, the dam is 18 miles north on Route 30.

The project, along with Ball Mountain Lake situated 9.5 miles upstream, provides flood protection to Townshend, Dummerston, Newfane, Brookline, and Brattleboro, all situated on the West River. Along with other Corps dams in the Connecticut River Basin, Townshend Lake also reduces downstream flood stages on the Connecticut River. During this storm, the flood storage area behind the dam was filled to capacity and excess water had to be discharged through the spillway.

Construction of the project began in November 1958 and was completed in June 1961 at a cost of \$7.4 million. The project consists of an earthfill dam with stone slope protection 1,700 feet long and 133 feet high; a gated 360-foot-long horse-shoe-shaped concrete conduit with a diameter of 20 feet six inches; and a spillway cut in rock with a 439-foot-long concrete L-shaped ogee weir. The weir's crest elevation is 30 feet lower than the top of the dam. About 4.3 miles of highway and four miles of electric and telephone lines were relocated to accommodate the project.

Townshend Lake has a permanent pool of 95 acres with a maximum depth of 21 feet. The flood storage area of the project totals 735 acres and extends 4.5 miles upstream through Jamaica. The project and all associated lands cover 1,219 acres. Townshend Lake can store up to 11 billion gallons of water for flood control purposes. This is equivalent to 5.8 inches of water covering its drainage area of 106 square miles.

Located in the heart of the scenic West River Valley and near an historic covered bridge, Townshend Lake provides a variety of recreational opportunities. The picnic area offers 100 tables and 65 fireplace grills; three picnic shelters; swimming on 800 feet of beach; boating (power boats allowed up to 10 horsepower); a 1.7-mile-long marked hiking trail; cross-country skiing and snowmobiling on unmarked trails, includ-

ing old Route 30; an open field for ball playing; horseshoe pits; a change house; drinking water; and sanitary facilities. There is excellent fishing in both the reservoir and along 2.8 miles of upstream river. While the state stocks rainbow trout, brown trout, and salmon, the river and lake support self-sustaining brook trout, smallmouth and largemouth bass, bullhead, rock bass, sunfish, and yellow perch. There is in-season hunting/trapping for native deer, wild turkey, red fox, ruffed grouse, woodcock, coyotes, raccoon, squirrel, rabbit, beaver, muskrat, mink, and fisher.

The recreational resources at Townshend Lake complement the neighboring Townshend State Forest, a 35-campsite facility operated by the Vermont Department of Forests, Parks, and Recreation.

The 1986 Water Resources Development Act passed by Congress authorized the Corps to design, construct, and operate facilities that will enable upstream migrant adult Atlantic salmon to bypass the dams at Townshend and Ball Mountain Lakes. The law also authorized the Corps to provide the necessary facilities for the downstream passage of juvenile salmon. A \$925,000 fish passage project on the West River was completed by the Corps in January 1993 encompassing both Ball Mountain and Townshend lake dams. The facility at Townshend Lake consists of the construction of a fish trap to collect upstream migrant salmon which would then be transported via tank truck above the dam to release points at both Ball Mountain and Townshend lakes. Modifications were made at both Ball Mountain and Townshend lakes to allow for downstream migration of juvenile salmon as well.

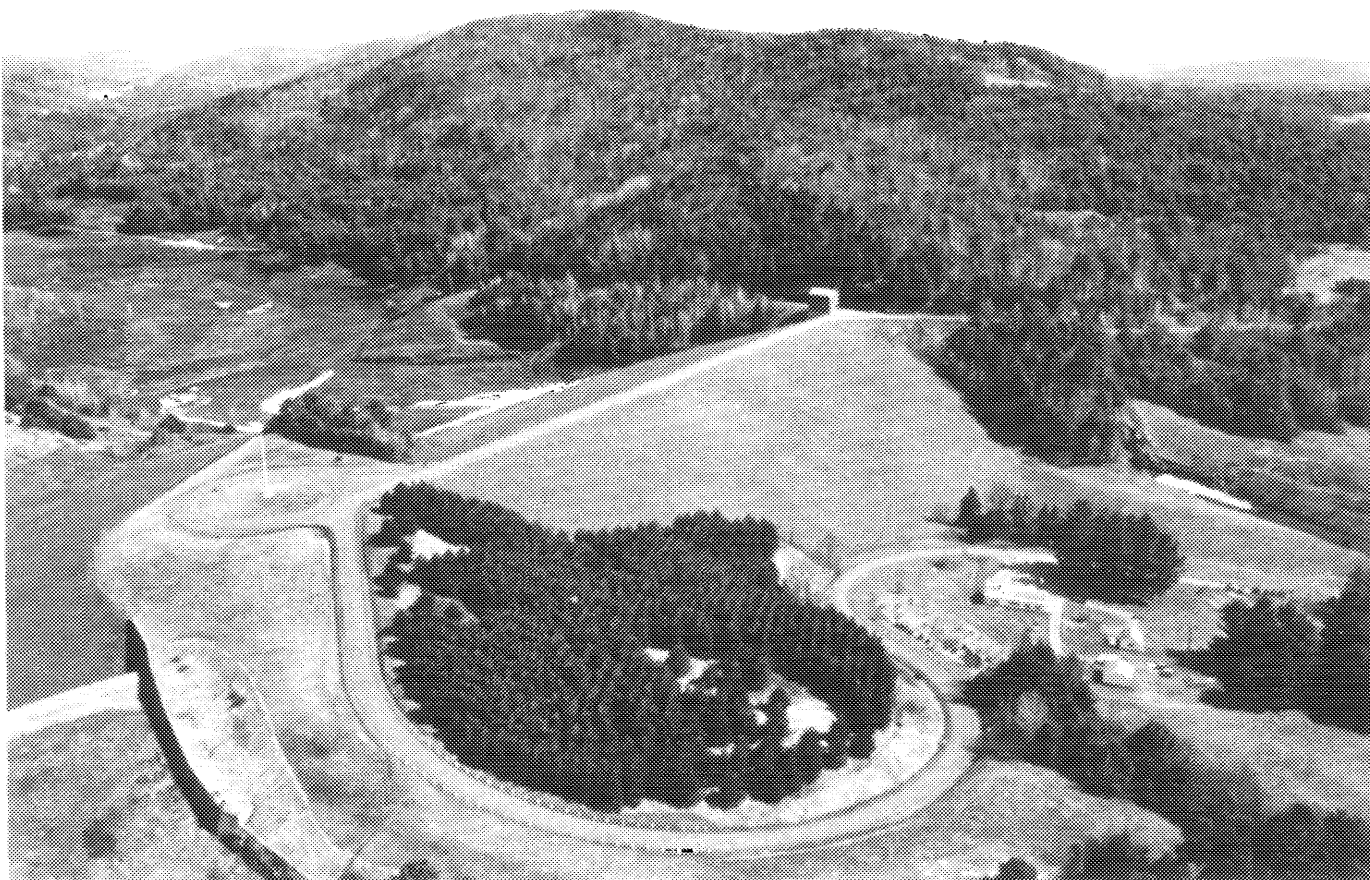
The normal pool elevation of 65 feet at Ball Mountain Lake is reduced to 25 feet each year to attract the juvenile salmon (April thru mid-June), and one of the three manual flood gate controls has been replaced with an automated gate operator which will automatically regulate outflows to assure that the 25-foot pool elevation will be maintained during normal flows.

At Townshend Dam, a splash weir was constructed within the intake weir structure upstream of the center flood control gate to form a splash pool to protect juvenile salmon from injury due to the 20-foot drop to the inlet weir floor. A one-foot V-notch was cut into the inlet weir to allow the juvenile salmon to enter the outlet during low flow periods. It is estimated that 75,000 to 80,000 juvenile salmon will pass downstream annually on their migration to the ocean.

## Union Village Dam

Union Village Dam in Thetford is situated on the Ompanoosuc River, four miles above its confluence with the Connecticut River and 11 miles north of White River Junction. From White River Junction, the dam can be reached by traveling U.S. Route 5 north to Route 132 west to Union Village Road, then following signs to the project.

Union Village Dam provides flood protection to the Union Village section of Thetford, Norwich, and the White River



*Union Village Dam*

Junction and Wilder Village sections of Hartford. It also reduces flood damage in the New Hampshire communities of Hanover and West Lebanon. In conjunction with other Corps dams and reservoirs in the Connecticut River Basin, Union Village Dam reduces flood damages in communities situated downstream on the Connecticut River.

Construction of Union Village Dam began in March 1947 and was completed in June 1950 at a cost of \$4.1 million. The project consists of an earthfill dam with stone slope protection 1,100 feet long and 170 feet high; a gated 1,167-foot-long circular concrete conduit with a diameter of 13 feet; and a chute spillway cut in rock with a 388-foot-long concrete ogee weir. The weir's crest elevation is 20 feet lower than the top of the dam. Approximately two miles of highway were relocated to accommodate the project.

There is no lake at Union Village Dam except during the winter, when a 50-acre lake with a depth of 20 feet is maintained to keep the floodgates from freezing. The flood storage area of the project totals 740 acres and extends 3.5 miles upstream. The project and associated lands cover 983 acres. Union Village Dam can store up to 12.4 billion gallons of water for flood control purposes. This is equivalent to 5.65

inches of water covering its drainage area of 126 square miles.

There are five small picnic areas located on River Road, a 3.1-mile-long road that runs through the project. The first picnic area, the Main Gate Area, is located at the entrance to the dam. It has four tables and four fireplaces, as well as a picnic shelter with eight tables. The second picnic area, located immediately behind the dam, has two tables and two fireplaces. The third picnic area, known as the Gorge Area, is .25 mile north of the second picnic area. It has three tables and three fireplaces. The fourth area is Sandy Beach, about .25 mile north of the Gorge Area. Sandy Beach has one table and one fireplace. The fifth picnic area, Skimobile Bridge Area, is about .5 mile north of Sandy Beach and has two tables and one fireplace.

There is swimming along the three miles of the Ompompanoosuc River's East Branch that runs through project lands. Sandy Beach offers a formal swimming area, with about 100 feet of beach. Three marked hiking trails — the .75-mile-long Mystery Trail, the 1.3-mile-long Forest Management Demonstration Trail, and the .9-mile-long Low Trail — are popular with visitors. Project lands are also used for cross-country skiing and snowmobiling. Sanitary facilities are available at the Main Gate Picnic Area.

The Ompompanoosuc River offers good fishing for stocked rainbow, brown, and brook trout. The river also supports self-sustaining yellow perch and white sucker. There is in-season hunting and/or trapping for deer, partridge, rabbit, muskrat, beaver, mink, and squirrel.

## Waterbury Reservoir

The dam at Waterbury Reservoir in Waterbury is situated on the Little River, about 2.5 miles above its confluence with the Winooski River. From Waterbury, the dam can be reached by travelling two miles west on U.S. Route 2, then right on Little River Road for three miles.

In conjunction with East Barre Dam and Wrightsville Reservoir, Waterbury Reservoir provides flood protection to the downstream communities of Duxbury, Bolton, Richmond, Williston, Jericho, Essex, Colchester, Burlington, South Burlington, and Winooski.

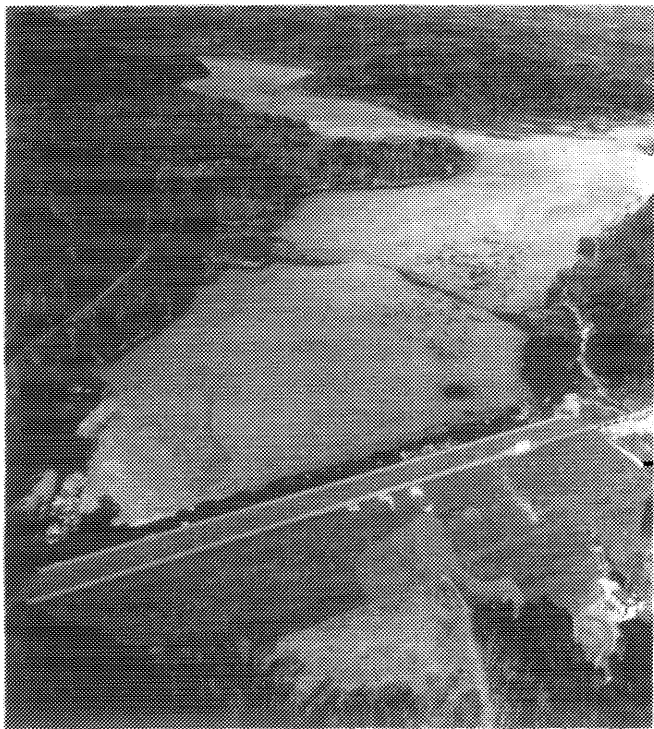
Construction of the project began in April 1935 and was completed in October 1938. The project consists of an earthfill dam with stone slope protection 1,845 feet long and 187 feet high; an 882-foot-long semicircular concrete conduit 10.5 feet high and 14 feet wide; two 230-foot-long steel conduits, each with a diameter of four feet six inches; a 290-foot-long steel circular conduit with a diameter of four feet; three 26.5-foot-high tainter gates, with two gates each measuring 20 feet wide and the third 35 feet wide; and a spillway cut in rock with a

154-foot-long concrete ogee weir. The weir's crest elevation is 15.5 feet lower than the top of the dam. Waterbury Reservoir was one of four flood damage reduction projects constructed in Vermont by the Civilian Conservation Corps (CCC) in the 1930s. Construction was overseen by the Corps' North Atlantic Division. Because of accounting procedures, the construction costs of Waterbury Reservoir were not calculated separately, but instead lumped together with the construction costs of East Barre Dam, Wrightsville Reservoir, and the Winooski River Local Protection Project. The construction costs of these four projects totalled \$13.7 million. Following completion, Waterbury Reservoir and associated lands were turned over to the State of Vermont for operation and maintenance.

The present day configuration of the dam is the result of two major modifications that allow a greater amount of water to pass through the spillway, increasing the dam's structural integrity. The first modification, which began in September 1956, included raising the dam three feet and installing the 35-foot-wide tainter gate. This work was completed in November 1959 at a cost of \$861,000. The second modification began in January 1985 and involved constructing the 290-foot-long steel conduit, rebuilding the toe of the dam, and grouting the dam's foundation to control seepage. This work was completed in December 1985 at a cost of \$4.8 million.

For most of the year, Waterbury Reservoir has a pool of 860 acres with a maximum depth of approximately 100 feet. During the winter, the pool is drained to a surface area of between 250-300 acres by the Green Mountain Power Corporation, owners of the hydroelectric power plant at the base of the dam (see below), in anticipation of spring rains and snowmelt. The flood storage area of the project, which is normally empty and utilized only to store floodwaters, totals 1,330 acres and extends approximately six miles upstream through Stowe. The project and all associated lands (including part of Mount Mansfield State Forest) cover 12,912 acres. Waterbury Reservoir can store up to nine billion gallons of water for flood control purposes. This is equivalent to 4.8 inches of water covering its drainage area of 109 square miles.

The main recreational attraction at Waterbury Reservoir is the Little River State Park, a 1,100-acre block within the larger 37,000-acre Mount Mansfield State Forest. Little River State Park has a 60-acre campground on the western shore of the reservoir containing 101 campsites (20 of these sites have lean-tos), each with its own picnic table and fireplace. There are two designated swimming areas: Area A has about 300 feet of beach situated on one side of Stevenson's Brook Cove, and Area B, located approximately 650 feet across the cove, has about 150 feet of beach. Little River State Park also has an excellent marked trail system, with dozens of hiking trails totalling about 30 miles. During the winter, about 17 miles of trail are marked for snowmobiling, with the remainder marked for cross-country skiing. The campground has a boat ramp (located in Area A); boat rentals; hot showers; drinking water; and sanitary facilities.



*Waterbury Reservoir*

History buffs take note: There are three areas of archeological and historical significance within the Little River State Park. They are:

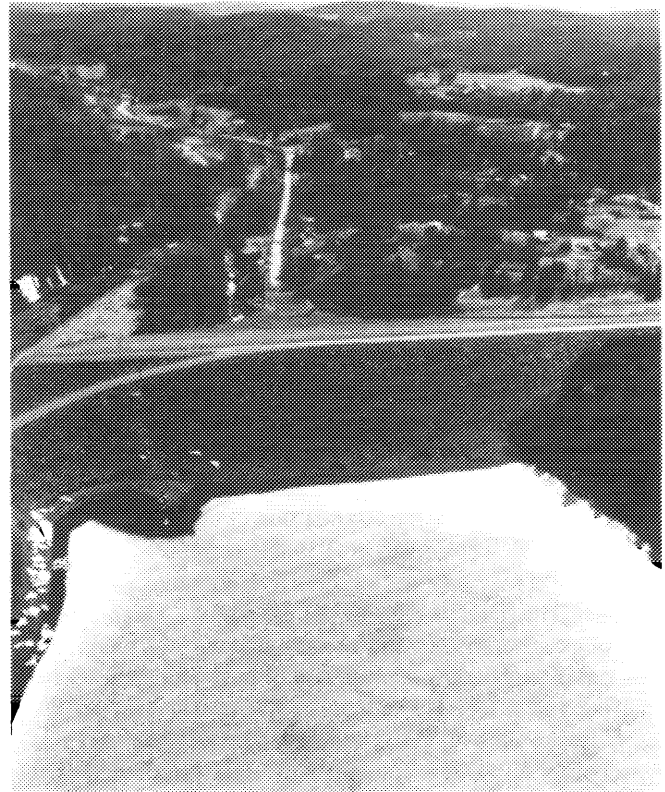
- The Civilian Conservation Corps campsite used by the workers constructing the dam at Waterbury Reservoir. Between 1933 and 1939 over 2,000 men lived and worked here. At one time, this self contained community featured more than 80 buildings. Although a few foundations exist, none of the buildings remain. This area is located on Little River Road, about .25 mile southwest of the dam.
- The foundations of a farm community dating back to the late 1800s. This site is situated about 2.5 miles northwest of Stevenson's Brook Cove.
- Several foundations of farmhouses dating back to the late 1700s. These are located near Cotton Brook, about eight miles north of dam. Note that the final six miles of travel must be made through woods; this site is not directly accessible by car.

Another recreational area enjoyed by visitors to Waterbury Reservoir is the Waterbury Reservoir Day Use Recreation Area, a 90-acre peninsula situated on Town Highway 17 (Old River Road), about .25 mile off Route 100. This site offers picnicking on 12 tables and 10 charcoal grills; swimming on 220 feet of beach; a concrete boat ramp; snowmobiling and cross-country skiing on unmarked trails; and sanitary facilities.

Three other areas offer limited recreational opportunities. The Waterbury Reservoir Boat Launch Area is located immediately behind the dam and provides boaters with an area in which to unload. The Blush Hill Recreation Area, located on Route 100 about six miles north of the dam, offers snowmobiling on marked trails. The Little River Canoe Access Area, located on Moscow Road (off Route 100) about five miles north of the dam, allows canoeists easy access to the reservoir. All of the above-mentioned recreational areas are operated and maintained by the Vermont Department of Forests, Parks, and Recreation, except for the Waterbury Reservoir Boat Launch Area, which is operated and maintained by the Vermont Department of Environmental Conservation.

There is fishing throughout the reservoir area. The state stocks rainbow and brown trout, and the reservoir contains self-sustaining smallmouth bass, yellow perch, brown bullhead, fallfish, golden shiners, pumpkinseed, white suckers, and longnose suckers. The state has also introduced smelt eggs to the Little River. Ice fishing is permitted. There is in-season hunting for native deer, ruffed grouse, and gray squirrel.

In June 1953, private interests completed construction of a hydroelectric power plant situated at the base of the dam. This facility, the Little River Hydro Station, generates approximately 5.5 megawatts of power, which is used by the Green Mountain Power Corporation.



*Wrightsville Reservoir*

## Wrightsville Reservoir

The dam at Wrightsville Reservoir in Montpelier is located on the North Branch of the Winooski River, about 40 miles southeast of Burlington. From Montpelier, the dam is three miles north on Route 12.

The project provides flood protection primarily to Montpelier. In conjunction with East Barre Dam and Waterbury Reservoir, the project also reduces flood damage in other downstream communities, including Middlesex and Waterbury on the Winooski River.

Construction of the project began in August 1933 and was completed in October 1935. The project consists of an earthfill dam with stone slope protection 1,525 feet long and 115 feet high; a 645-foot-long concrete rectangular conduit divided into three barrels, with one barrel plugged, one barrel leading to the Wrightsville Hydroelectric Power Plant (see below), and the third measuring 5.25 feet wide and 5.25 feet high; and a spillway cut in rock with a 155-foot-long concrete ogee weir. The weir's crest elevation is 30 feet lower than the top of the dam. Wrightsville Reservoir was one of four flood damage reduction projects constructed in Vermont by the Civilian Conservation Corps in the 1930s. Construction was overseen by the Corps' North Atlantic Division. Because of accounting procedures, the construction costs of Wrightsville Reservoir were not calculated separately, but instead lumped together with the construction costs of East Barre Dam, Waterbury

Reservoir, and the Winooski River Local Protection Project. The construction costs of these four projects totalled \$13.7 million. Following completion, Wrightsville Reservoir was turned over to the State of Vermont for operation and maintenance.

The present day configuration of the dam is the result of a major modification that allows a greater amount of water to pass through the spillway, increasing the dam's structural integrity. Started in October 1956, the modification included raising the dam 20 feet and lengthening it 275 feet, and widening the spillway discharge channel. A 1,920-foot-long section of a town road was relocated across the top of the dam. The work was completed in September 1958 at a cost of \$1.35 million.

Prior to 1985, Wrightsville Reservoir had a permanent recreational pool of 90 acres with a maximum depth of about 10 feet. However, since the construction of the Wrightsville Hydroelectric Power Project in 1985, the permanent recreational pool is now kept at 190 acres with a maximum depth of 25 feet. The flood storage area of the project, which is normally empty and utilized only to store floodwaters, totals 570 acres and extends one mile upstream through Middlesex. The project and all associated lands cover 836 acres. Wrightsville Reservoir can store up to 6.6 billion gallons of water for flood control purposes. This is equivalent to 5.6 inches of water covering its drainage area of 68.1 square miles.

Wrightsville Reservoir was originally constructed without any recreational facilities. In November 1964, the Corps began work on providing the lake with three recreational areas and completed the project in June 1967 at a cost of \$204,600 (the state provided fireplaces, picnic tables, drinking water, and sanitary facilities). In November 1967, the Corps turned over these recreational areas to the Vermont Department of Environmental Conservation. One area, the Shady Rill Recreation Area, is approximately 1.25 miles north of the dam (the .25-mile-long access road to Shady Rill is directly off Route 12). The Shady Rill Recreation Area offers picnicking on 10 tables and five fireplaces, a picnic shelter, an open field for ball playing, horseshoe pits, and sanitary facilities. Martins Brook, also known as Shady Rill Brook, offers picnickers a streamside environment. The second recreation area is the

Wrightsville Reservoir Boat Launch Area, located on Route 12, about .75 mile north of the dam. This area offers a boat ramp and sanitary facilities. Cross-country skiing and snowmobiling on unmarked trails, as well as ice fishing, can be enjoyed during the winter.

The third recreational area built by the Corps at Wrightsville Reservoir has since been closed. However, in 1985, the Washington Electric Cooperative constructed a recreational facility in conjunction with the Wrightsville Hydroelectric Power Project it was concurrently building at Wrightsville Reservoir. This area, the Wrightsville Beach Recreation Area, is located on Route 12, about 1.25 miles north of the dam (opposite the access road leading to the Shady Rill Recreation Area). The Wrightsville Beach Recreation Area offers picnicking on 36 tables, 11 fireplace grills, a picnic shelter, swimming on 350 feet of beach, hiking on a one-half-mile long marked trail, an open field for ball playing, a small playground area, cold showers, drinking water, and sanitary facilities. Also offered are horseshoe pits and a volleyball net, with both the horseshoes and volleyball available in the office. When the Wrightsville Beach Recreation Area was completed, the Washington Electric Cooperative turned it over to the Wrightsville Beach Recreation District for operation and maintenance. The Wrightsville Beach Recreation District is comprised of the communities of Middlesex, Worcester, Montpelier, and East Montpelier.

Boating is permitted throughout Wrightsville Reservoir, although speed is restricted in the Wrightsville Beach Recreation Area.

There is fishing throughout Wrightsville Reservoir. The state stocks brown trout, and the lake supports self-sustaining white suckers, yellow perch, brown bullhead, pickerel, golden shiners, and pumpkinseed. Smallmouth bass have been introduced to the reservoir. Reservoir lands offer in-season hunting for waterfowl and trapping for muskrat.

In February 1985, the Wrightsville Hydroelectric Power Project was completed on North Branch, approximately 200 feet downstream of the dam at Wrightsville Reservoir. The facility began to generate power in September 1985. The plant has the capacity to produce 1.2 kilowatts of power, which is used by the Washington Electric Cooperative.

## LOCAL PROTECTION PROJECTS

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Bailey Dam, Montpelier  
Bennington  
Hartford  
Lamoille River, Cambridge and Hardwick  
Richford  
Roaring Branch, Arlington  
Roaring Branch, Bennington  
Weston  
Winooski River, Middlesex and Montpelier



*The Bailey Dam Local Protection Project, located on the Winooski River, reduces ice jams and resultant flooding in Montpelier.*

## Bailey Dam, Montpelier

The Bailey Dam Local Protection Project is located on the Winooski River in Montpelier.

The project reduces ice jams and resultant flooding on the Winooski River. Data on damages prevented are not available.

Bailey Dam, originally called the Montpelier Dam, was completed in October 1934 as part of the Winooski River Local Protection Project. The work described below was completed between August-November 1975 as a small project under Section 208 of the Continuing Authorities Program. Construction was overseen by the Corps' New York District. The project cost \$250,000 and is operated and maintained by Montpelier.

The project included the removal of the dam's tainter gates and supporting piers, a concrete walkway, and a portion of the spillway; and the construction of an approximately three-foot-high concrete cap on top of the existing sill and a six-foot-high cap on the spillway.

## Bennington

The Bennington Local Protection Project is located along the left bank of Roaring Branch, a tributary of the Walloomsac River, in Bennington.

The project protects Bennington from damage caused by the floodwaters of Roaring Branch.

Construction of the project, built by the Corps' New York District began in June 1970 and was completed in November

1971 at a cost of \$670,000. The project is operated and maintained by Bennington.

The project, about one mile in length, begins about 1,000 feet upstream of the Brooklyn Bridge and ends on Park Street. It consists of:

- Two sections of earthfill dike with stone slope protection, that total 3,710 feet. The first section, about four feet high, begins about 1,000 feet upstream of the Brooklyn Bridge and extends downstream for 530 feet. The second section begins about 700 feet downstream of the Brooklyn Bridge and ties into high ground adjacent to Mount Anthony Union High School on Park Street. This dike is 3,180 feet long and averages six feet high.
- Three sections of concrete floodwall with stone slope protection that total 1,472 feet. These include two sections of newly constructed concrete floodwall totalling 147 feet, and a 1,325-foot-long floodwall that was originally built by the town as a Works Progress Administration (WPA) project in 1939. The first section of floodwall, newly constructed, starts about 500 feet upstream of the Brooklyn Bridge and extends for 34 feet before tying into the second section of floodwall, which is the WPA floodwall. The third section of floodwall is located immediately downstream of the WPA floodwall and is 116 feet long.
- Four drainage structures. One is located along the east side of Park Street, about 400 feet southeast of the Park Street Bridge; the second is located about 130 feet from the northeast end of Congress Street; the third is located about 70 feet from the northeast end of Bradford Street; and the fourth is located approximately 610 feet northeast of the intersection of Branch and Gage Streets.
- A ponding area, measuring about 350 feet by 250 feet, that impounds excess storm water in conjunction with the first drainage structure described above. The ponding area is located on the east side of Park Street, about 450 feet south of the Park Street Bridge.
- A pumping station located adjacent to the ponding area and the first drainage structure.

During the floods of December 1948 and August 1950, a 725-foot-long section of the WPA-built floodwall was seriously damaged. The Corps reconstructed this section of floodwall as a small project under Section 208 of the Continuing Authorities Program. Construction was initiated in July 1951 and was completed in April 1952 at a cost of \$196,000. This 725-foot-long section of the WPA-built floodwall was later incorporated as part of the Bennington Local Protection Project.

During August 9-12, 1976, heavy rains from Hurricane Belle caused flooding throughout Vermont. These rains undermined a 250-foot-long section of floodwall by dislodging the stone slope protection at its base and exposing its footing. The placement of additional stone slope protection to secure the floodwall was completed in June 1977 at a cost of \$18,000.



*The Bennington Local Protection Project protects Bennington from damage caused by the floodwaters of Roaring Branch. The left photo shows a section of the 1,472-foot-long concrete floodwall (bottom arrow); the beginning of the 3,180-foot-long dike (middle arrow); and the end of the dike (top arrow). The Brooklyn Bridge spans Roaring Branch in the lower part of the photo.*

## Hartford

The Hartford Local Protection Project is located on the White River at its confluence with the Connecticut River, in the White River Junction section of Hartford.

The White River is subject to ice-jam flooding, particularly in the reach that passes through the business and industrial center of White River Junction. In 1964, an ice jam raised water levels upstream of the Hartford Bridge an estimated 10 feet before the jam released, resulting in a downstream surge that destroyed the bridge. The Corps project reduces the threat of ice-jam flooding and subsequent damage to White River Junction's business area.

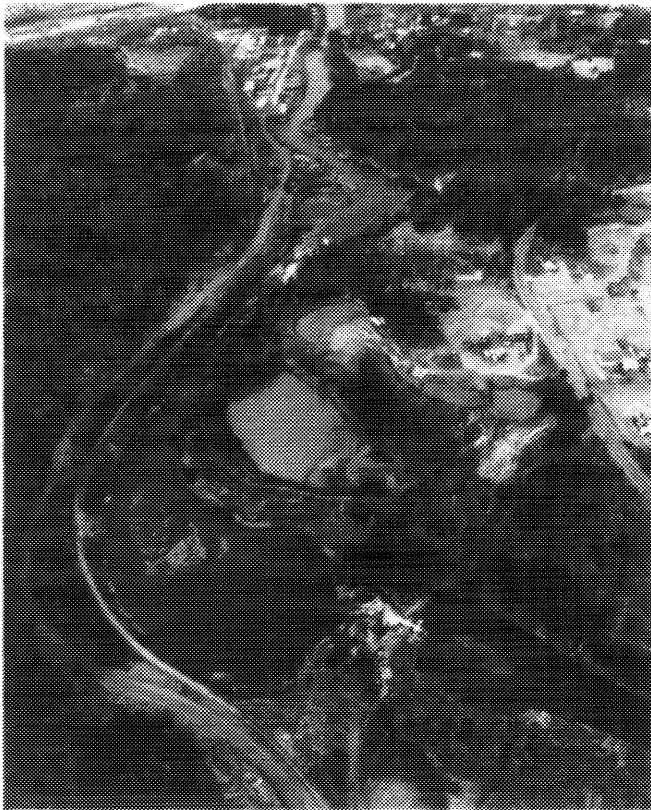
The project was completed between June-November 1970 at a cost of \$332,000. It was built as a small project under Section 205 of the Continuing Authorities Program, and is operated and maintained by Hartford.



*The Hartford Local Protection Project stretches along a two-mile reach of the White River (above), beginning at a point immediately upstream of the White River's confluence with the Connecticut River (top). The project involved rock removal and channel excavation.*

The project extends along a two-mile reach of the White River beginning at a point immediately upstream of its confluence with the Connecticut River. The work consisted of:

- Rock removal in three areas upstream of the Hartford Bridge, which is located about 1.5 miles from the junction of the White and Connecticut Rivers;
  - Rock removal and channel excavation of sand and gravel deposits in three areas downstream of the bridge;
  - Rock removal immediately upstream of the U.S. Route 91 Bridge, located about .9 mile from the junction of the rivers; and
  - Channel excavation on each side of the railroad bridge, located several hundred feet above the rivers' junction.
- The White River, 58 miles in length, rises on the northeast slope of Battell Mountain in Ripton and flows five miles easterly to Granville and 19 miles southerly through Hancock, Rochester, and Stockbridge. The river then changes direction and flows nine miles northeasterly to Bethel, seven miles easterly to Royalton, and 18 miles southeasterly through Sharon to its confluence with the Connecticut River at White River Junction in Hartford.



*Located along approximately 40 miles of the 84-mile-long river, the Lamoille River Local Protection Project involved enlarging the channel at Johnson Gorge in Johnson (above). The project has prevented flood damages estimated at \$2.7 million to Johnson and farmlands bordering the river.*

## Lamoille River, Cambridge and Hardwick

The Lamoille River Local Protection Project is located along approximately 40 miles of the 84-mile-long river. The project is situated along those areas of the river that flow through Hardwick, Wolcott, Morristown, Hyde Park, Johnson, and Cambridge.

The project provides flood protection to Johnson and farmlands bordering the river.

The channel improvement project was completed between March-August 1938 at a cost of \$50,000.

The project involved enlarging the channel at Johnson Gorge in Johnson and constructing bank revetment at four areas along the river — in Hardwick, Wolcott, Johnson, and Cambridge. Local interests completed bank revetment work at eight other areas along the river. These areas encompassed the towns of Hardwick (two areas), Wolcott (two areas), Morristown, Hyde Park, Johnson, and Cambridge.

The Lamoille River rises from Long Pond in Greensboro and flows westerly for 84 miles to Lake Champlain at Colchester. From Greensboro, the river passes through Hard-

wick, Wolcott, Morristown, Hyde Park, Johnson, Cambridge, Fletcher, Fairfax, Georgia, and Milton before emptying into Lake Champlain at Colchester.

## Richford

The Richford Local Protection Project is located on the Missisquoi River in Richford, at the confluence of the North Branch and Missisquoi River. The project is approximately one mile from the Canadian border.

The project is designed to reduce damages caused by ice jam flooding in the vicinity of Big Island, which is situated at a sharp bend in the river west of the town center.

Ice jams along this section of the Missisquoi River did not occur prior to 1950 when the Sweat and Comings Dam existed (The Sweat and Comings Company, a furniture manufacturing firm, used the dam for power generation and log transportation). The 12-foot-high stone and timber dam, located approximately 250 feet upstream of the Main Street Bridge, showed significant deterioration in the 1940s and was removed in 1947. The first ice jam of record in Richford occurred in March 1950, causing, according to one source, "the greatest amount of property damage since the flood of 1927." Significant ice jam flooding also occurred in March 1955, April 1959, March 1960, and February 1961.

In response to a request from Vermont state officials for assistance, the Corps constructed a project in Richford between December 1961 and June 1964 at the cost of \$221,000. The project was built by the Corps' New York District and is maintained by Richford.

The project involved:

- Excavating a new channel through Big Island for 1,870 feet.
- Excavating 2,010 feet of an existing channel. The work begins in the main channel at a point about 860 feet downstream of the Main Street Bridge and extends into the existing stream south of Big Island. The channel is 40 feet wide.
- Constructing a 160-foot-long stone weir on the left bank of the main channel to prevent ice jams.
- Constructing a 350-foot-long stone dike on the right bank of the main channel.
- Removing two shoals at the mouth of North Branch and a small island about 300 feet long in the Missisquoi River.

The Corps of Engineers has conducted a study on providing additional ice jam flood protection to Richford.

The Missisquoi River rises from mountain streams on the eastern slope of Belvidere Mountain in Lowell and flows northerly through Westfield and Troy before entering the province of Quebec. The river flows through the province for about 12 miles before reentering the United States at Richford. The river then flows westerly through Berkshire, Enosburg, Sheldon, and Highgate, and enters Lake Champlain at Swanton. The river has a total length of 88 miles.



*The Richford Local Protection Project on the Missisquoi River in Richford is designed to reduce damages caused by ice jam flooding in the vicinity of Big Island. The photo shows Big Island and the main Missisquoi River channel (lower channel in the photo). This channel was excavated for a distance of 2,010 feet, and two shoals were removed at the confluence of the Missisquoi River and North Branch (lower left). A new 1,870-foot-long channel (arrow) was excavated through Big Island.*

## Roaring Branch, Arlington

The Roaring Branch Local Protection Project in Arlington is located on Roaring Branch in the town's East Arlington section. This stream, a tributary of the Batten Kill, is one of two rivers in southern Vermont named Roaring Branch; the other is a tributary of the Walloomsac River and passes through Bennington. The snagging and clearing project improves the flow capacity of Roaring Branch, thereby reducing the threat of flooding along this section of stream. Data on damages prevented are not available.

The project was completed by the Corps' New York District between August-October 1950 at a cost of \$10,000. It is maintained by Arlington.

The work involved clearing accumulated gravel, boulders, and eroded material from about 1,000 feet of Roaring Branch channel. The excavated material was deposited along a 300-foot-long section of an earthen dike lying adjacent to Roaring Branch that had been washed out from Roaring Branch floodwaters in December 1948.

## Roaring Branch, Bennington

The Roaring Branch Local Protection Project in Bennington is located on Roaring Branch. This stream, a tributary of the Walloomsac River, is one of two rivers in southern Vermont named Roaring Branch; the other is a tributary of the Batten Kill and passes through Arlington.



*The snagging and clearing of 1,000 feet of Roaring Branch in Arlington (above) improves the stream's flow capacity and reduces the threat of flooding.*

The snagging and clearing project improves the flow capacity of Roaring Branch, thereby reducing the threat of flooding along this section of stream in Bennington. Data on damages prevented are not available.

Floodwaters in December 1948 and August 1950 cluttered a section of the channel with gravel and boulders. This debris reduced the streamflow capacity of Roaring Branch and caused a potentially dangerous flooding situation. The project improves the flow capacity of the stream to its pre-flood condition. Completed by the Corps' New York District between July-November 1951, the project cost \$46,000 and is maintained by Bennington.

The work consisted of excavating accumulated gravel and boulders from about 3,000 feet of channel. This material was deposited at four critical sections along the left bank to form earthen dikes.

## Weston

The Weston Local Protection Project is located on the West River in Weston, about 21 miles northwest of Bellows Falls and 45 miles upstream of the confluence of the West and Connecticut rivers in Brattleboro.

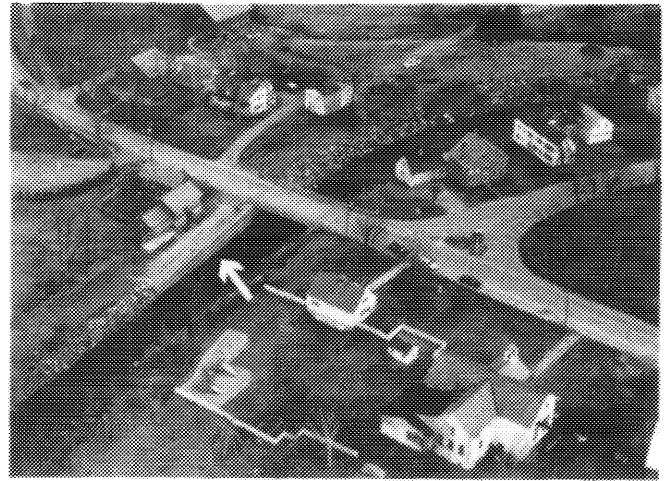
The existing project provides protection from moderate flooding to the Weston Playhouse, Weston Inn, and Community House; town offices and four residences; a school, store, and playground; and adjacent roadways. Data on damages prevented are not available.

In June 1952, moderate flooding from the West River damaged public and private property. To prevent damage from similar flooding, the Corps designed and built a project between June 1956 and July 1957 at a cost of \$14,800. It was constructed as a small project under Section 208 of the Continuing Authorities Program. In 1973 and again in 1976, heavy flooding significantly damaged the project. The original project and the rehabilitation work are described below. The project is operated and maintained by Weston.

The original project included deepening and widening the channel; clearing, snagging, and removing boulders from the streambed; constructing 1,335 feet of stone slope protection; constructing a 83-foot-long earthfill dike with stone slope protection, and a stop-long structure, both at the Vermont Guild Mill Building; and repairing a section of masonry wall on a section of the left bank upstream of the Landgrove Street Bridge. This work extended along 1,700 feet of the West River downstream of the Vermont Guild Dam and protected an area between Route 8 and the West River.

In June 1973, the West River overflowed its banks between the Guild Mill and the Landgrove Street Bridge, a distance of about 450 feet. The resultant flooding damaged town offices, the town common, the Memorial Library, homes, roadways, and other public buildings. The stone walls on both riverbanks were undermined, and some sections either ruptured or collapsed, leaving the streambed and banks cluttered with debris. The Corps responded by constructing stone slope protection and retaining walls on the banks, and restoring the concrete masonry walls. The Corps also replaced a washed out culvert at Parker Lane Brook, replaced concrete sidewalks, and relocated an electrified cattle fence. This restoration work, constructed under the Corps' emergency repairs authority (Public Law 99 of the Flood Control Act of 1941), extended along a 900-foot reach of the river and was completed between October-November 1973 at a cost of \$175,000.

During August 10-12, 1976, heavy flooding from Hurricane Belle damaged two riverbank areas and left them vulnerable to erosion. Four months later, stone reinforcements were placed on the eroded banks to provide them with emergency protection. However, high river flows caused by a subsequent storm washed out the stone reinforcements, leaving the banks unstable and subject to further erosion. During the next 20 months, the Corps restored stone slope protection upstream of the Landgrove Street Bridge, constructed a gabion retaining wall downstream of the bridge, and replaced a pipe rail fence. This



*The Weston Local Protection Project included clearing, snagging, and removing boulders from the West River channel; deepening and widening the stream; constructing stone slope protection on the riverbanks; and constructing retaining walls. The photo shows a gabion retaining wall (arrow), and stone slope protection on either side of the wall at the Landgrove Street Bridge. The entire project extends along 1,700 feet of the West River.*

work, constructed under the Corps' emergency repairs authority (Public Law 99 of the Flood Control Act of 1941), was completed in August 1978 at a cost of \$93,700 (including the stone reinforcement emergency protection work).

The West River rises in Mount Holly and flows seven miles southerly to Weston, then southeasterly for 46 miles through Londonderry, Jamaica, Townshend, and Newfane before joining the Connecticut River at Brattleboro.

## Winooski River, Middlesex and Montpelier

The Winooski River Local Protection Project is located along an approximately 6.5-mile-long stretch of river that flows through Montpelier, Berlin, Moretown, and Middlesex.

In conjunction with East Barre Dam, Waterbury Reservoir, and Wrightsville Reservoir, the Winooski River Local Protection Project protects several thousand acres of farmland and reduces flood damage in many downstream communities, including Montpelier, Middlesex, Waterbury, and Duxbury. Data on damages prevented are not available.

Construction of the project began in 1934 and was completed in the spring of 1938. The Winooski River Local Protection Project was one of four flood damage reduction projects built in Vermont by the Civilian Conservation Corps in the 1930s. Construction was overseen by the Corps' North Atlantic Division. Because of accounting procedures, the construction costs of this project were not calculated separately, but instead lumped together with the construction costs of East Barre Dam, Waterbury Reservoir, and Wrightsville Reservoir. The

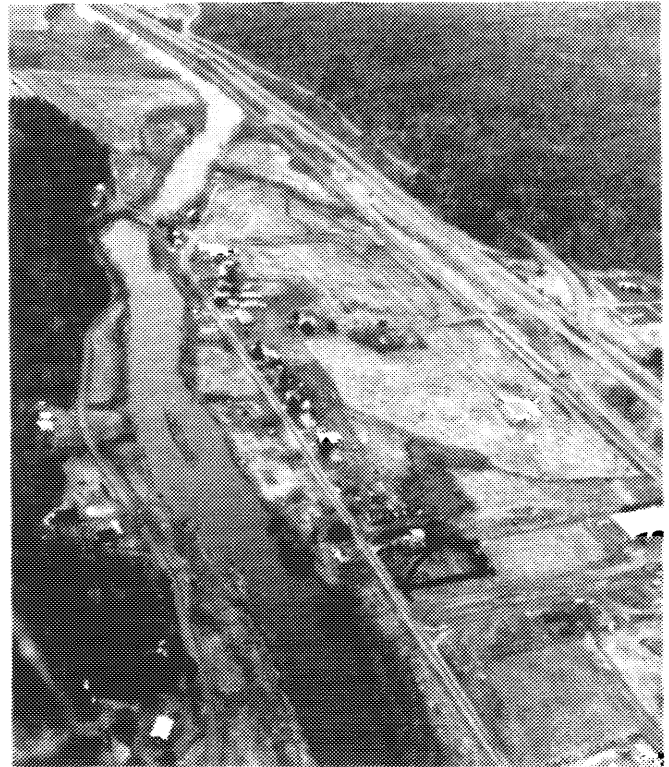
construction costs of these four projects totalled \$13.7 million.

The project consisted of:

- Replacing an old timber dam at Montpelier by a small concrete dam (now called Bailey Dam) with tainter gates.
- Clearing and grading one mile of river bank above the dam. In the upper half-mile of this reach, several sections of the banks were cut back considerably to enlarge the channel. Stone slope protection was then placed on these sections of bank.
- Removing projecting ledges and points that restricted Winooski River flows at five separate places between Middlesex and Montpelier. The removed ledge rock was used as part of the stone slope protection described above.

The Winooski River rises from Coits Pond in Cabot and flows for approximately 90 miles before emptying into Lake Champlain in Burlington. From Cabot, the river flows southwesterly through Marshfield, Plainfield, East Montpelier, and northeastern Berlin. At this point the river changes direction and flows in a northwesterly course through Montpelier, northwestern Berlin, Moretown, Middlesex, Waterbury, Duxbury, Bolton, Richmond, Williston, Jericho, Essex, South Burlington, Winooski, and Colchester before emptying into Lake Champlain at Burlington.

Following the devastating flooding of downtown Montpelier in March 1992, a new Corps study identified the severity of the problem and the feasibility of a Federal solution. Local interests were unwilling to cost-share any additional phases of study and project development.



*Located along an approximately 6.5-mile-long stretch of the river between Montpelier and Middlesex, the Winooski River Local Protection Project involved removing ledges and points that restricted the flow of the river. In conjunction with other flood damage reduction projects, the Winooski River Local Protection Project helps protect several thousand acres of farmland and reduces flood damage in many communities, including Montpelier, Middlesex, Waterbury, and Duxbury.*

# Navigation

The Corps has completed seven navigation projects in Vermont, all on Lake Champlain or associated waterways. These projects have, over the years, benefitted commercial interests and the many recreational boaters that enjoy Lake Champlain and its environs. (Five additional projects have been constructed on the New York side of Lake Champlain.)

After the Great Lakes, Lake Champlain is the largest freshwater lake in the United States. It has a length of 120 miles, a width of 12 miles at its widest crossing, and a mean depth of 64 feet, with some areas as deep as 400 feet. Except for a few shoal areas, the entire lake is navigable. Lake Champlain has a total area of 490 square miles — 435 square miles of surface water and 55 square miles of islands, of which there are over 70. Approximately 91 percent of water entering Lake Champlain is from tributaries. Unlike most waterways in the United States, Lake Champlain flows northerly, and empties into the Richelieu River near Ash Island (Ile aux Cendres) in the Town of Noyan, Quebec. The Richelieu River, in turn, flows northerly for approximately 40 miles before emptying into the St. Lawrence River at Sorel, Quebec.

Today, Lake Champlain is used mostly by a growing number of recreational boats and transient craft. The New York State Department of Transportation reports that, in 1989, a total of 26,756 craft went through at least one of the 11 locks on the Champlain Canal, which is situated between Waterford,

New York and Whitehall, New York, and leads to Lake Champlain. In 1980, only 11,892 boats went through at least one of the locks. Although some of these vessels may not have sailed as far as Lake Champlain, the two figures can be used as a guide to measure the increase in the lake's recreational boat traffic.

Conversely, commercial traffic at ports on Lake Champlain has declined markedly since 1980. Annual commercial tonnage in 1989 amounted to 224,746 tons. This compares with a 1980 figure of 701,780 tons. Approximately 99 percent of all commercial shipping in 1989 consisted of petroleum products, such as fuel oil, kerosene, gasoline, and jet fuel, which were distributed mainly to points around the lake.

The following pages describe the seven Corps' navigation projects on the Vermont side of Lake Champlain. Many of these projects date back to the 19th century and cost an aggregate \$1.59 million to construct. Construction of all projects built on Lake Champlain was overseen by the Corps' North Atlantic Division. Depths given for channels and basins are those at low tide.

*(Information on the five Corps' projects built on the New York side of Lake Champlain can be found in the booklet, "Water Resources Development in New York," published by the Corps' New York District).*

# NAVIGATION PROJECTS

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Burlington Harbor

Channel Between the North and South Hero Islands

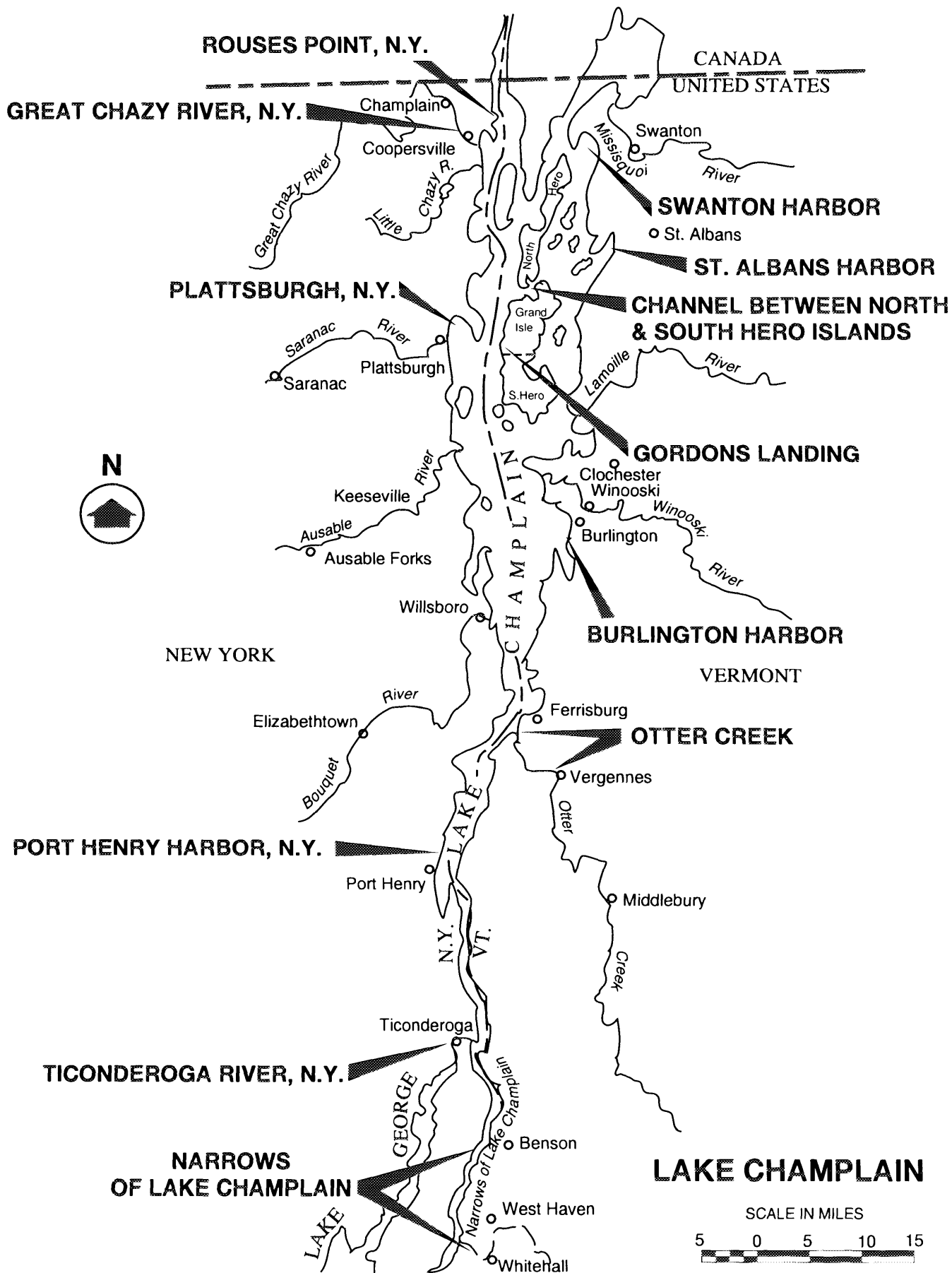
Gordons Landing

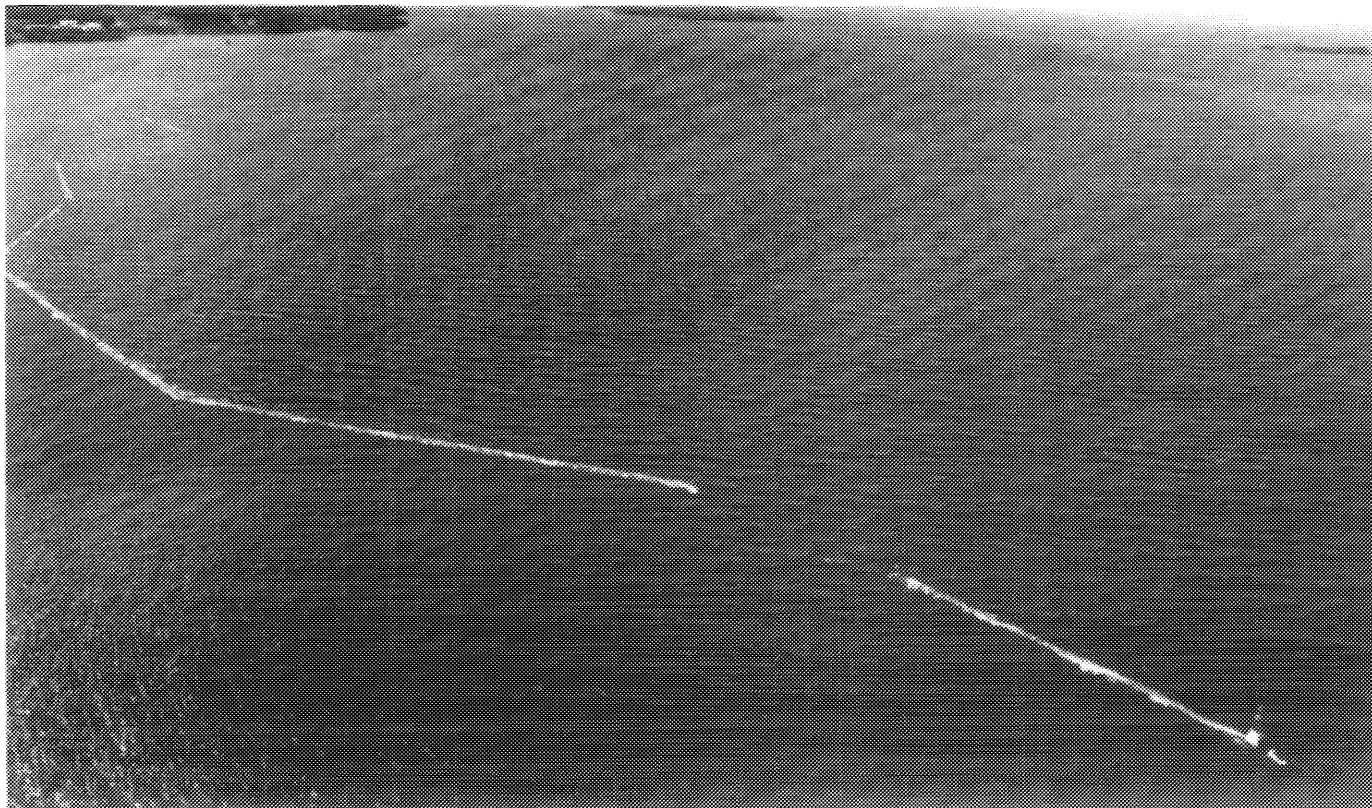
Narrows of Lake Champlain

Otter Creek

St. Albans Harbor

Swanton Harbor





*The breakwater in Burlington Harbor, on the eastern shore of Lake Champlain, is separated by a 200-foot gap that allows safe entrance into the harbor during storms. The northern (right) section of breakwater is 364 feet long, and the southern section is 3,793 feet long.*

## Burlington Harbor

Burlington Harbor in Burlington is located on the eastern shore of Lake Champlain, about 40 miles south of the United States-Canada border. Encompassing about 100 acres, the harbor serves as a receiving port for petroleum products and is a terminal for ferry traffic to Port Kent Harbor, New York. It is also used by a sizeable recreational fleet and transient pleasure craft.

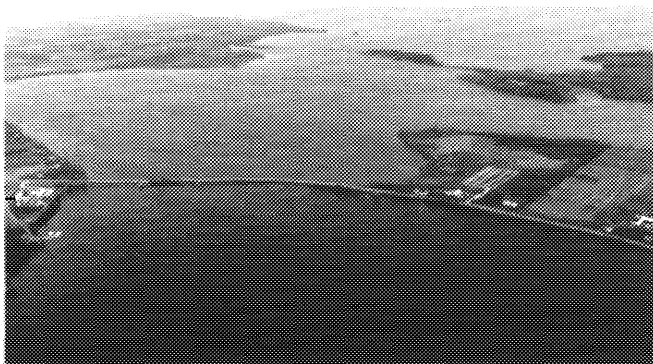
The project consists of a 4,157-foot-long stone and concrete breakwater located about 1,000 feet from shore and generally parallel with it. The structure is separated by a 200-foot gap that allows safe entrance into the harbor during storms. The northern section of breakwater is 364 feet long, and the southern section is 3,793 feet long. Although the breakwater was originally designed for a length of 6,000 feet, the present length is considered sufficient for the needs of navigation. The structure was completed in 1890.

The breakwater underwent major rehabilitation between 1962 and 1965 when it was recapped with stone and the lake-side slope was reinforced.

## Channel Between the North and South Hero Islands

North Hero Island, consisting of the community of North Hero, and South Hero Island, consisting of the communities of Grand Isle and South Hero, are situated in the middle of Lake Champlain. The channel between the islands, locally known as The Gut, lies about 17 miles south of the United States-Canada border. Frequently travelled at one time by commercial ships, no commerce has been reported on this waterway for decades. It is now used principally by recreational craft.

The project, completed in 1899 primarily to aid commercial navigation, consists of a two channels, each 10 feet deep and 150 feet wide, at both the east and west entrances to The Gut. The east channel is located roughly halfway between Knight Point in North Hero and Sandy Point in Grand Isle. The west channel is located roughly halfway between Bow Arrow Point in North Hero and Tromp Point in Grand Isle.



*The channel between North (right) and South Hero islands, locally known as The Gut, is used principally by recreational craft. The project consists of two smaller channels, each 10 feet deep and 150 feet wide, that pass under the bridges at each entrance to The Gut.*

## Gordons Landing

Gordons Landing in Grand Isle is situated on the western shore of South Hero Island on Lake Champlain and is about five miles east of Plattsburgh, New York. Gordons Landing serves as a terminal for ferry service across Lake Champlain to Cumberland Head in Plattsburgh Harbor.

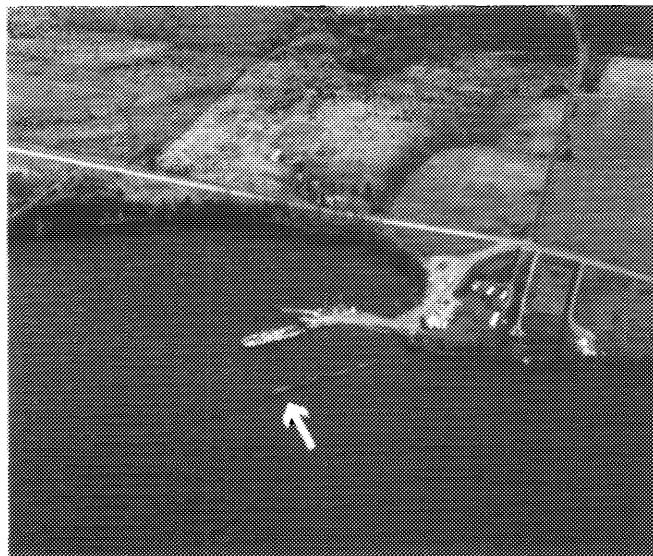
The project consists of a 675-foot-long stone breakwater extending northwesterly from the shore. Originally designed for a length of 800 feet, its present length was considered sufficient for the protection of the public landing. The structure was completed in 1891.

## Narrows of Lake Champlain

The Narrows of Lake Champlain is a 37-mile-long section of waterway at the southern end of Lake Champlain and forms a partial border between Vermont and New York. The waterway is used chiefly by recreational boats and commercial ships transporting petroleum products.

The project lies within the 37 miles of the Narrows and consists of a 13.5-mile-long, 12-foot-deep channel extending northerly from the canal lock at Whitehall, New York, past West Haven, to Benson Landing in Benson. The channel is generally 150 feet wide except at The Elbow, which is located in Whitehall across from West Haven and near the confluence of the Poultney and Mettawee Rivers. The width of the channel at this point is 110 feet. Fender booms were installed at The Elbow (specifically at Putts Leap and Putts Rock) and opposite the railroad trestle that crosses the inlet to South Bay. The railroad trestle is about one mile northwest of The Elbow. Work was completed in 1923.

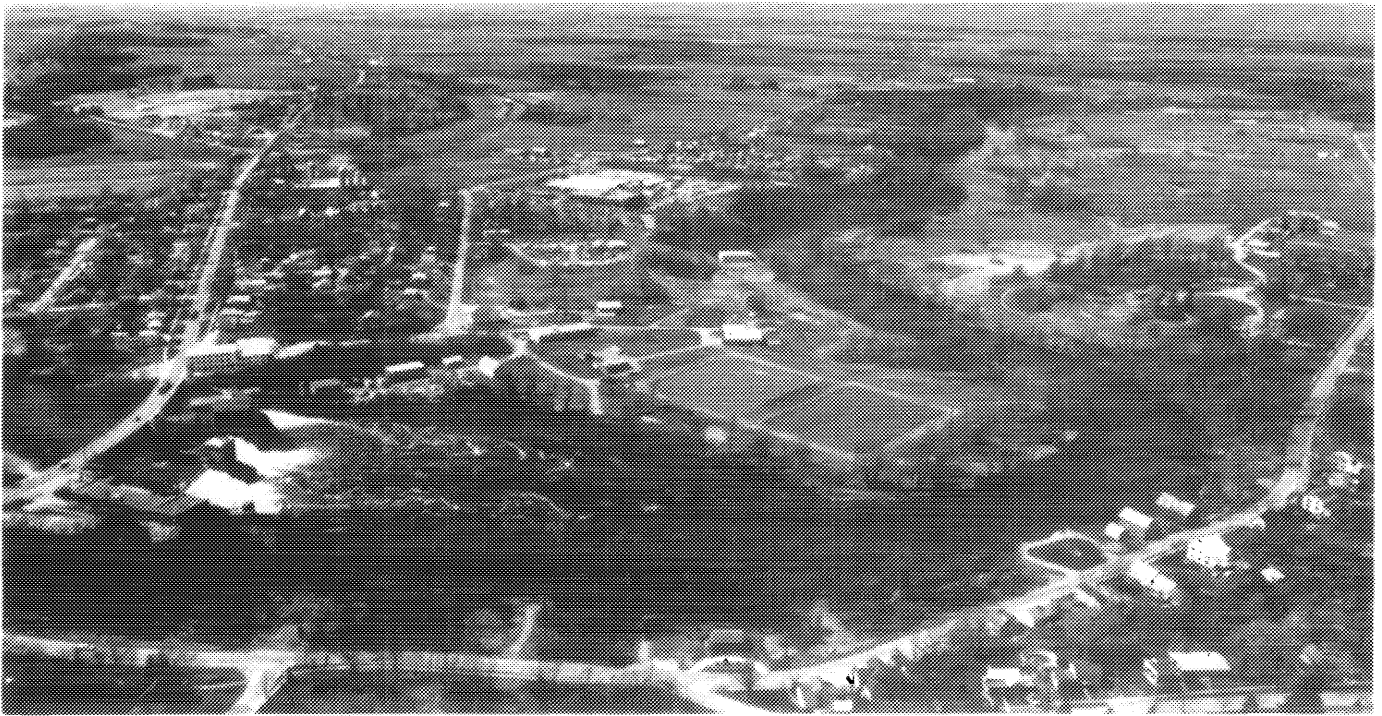
Originally designed for a channel width of 200 feet, the project is considered adequate for the safety of present day navigation.



*A 675-foot-long stone breakwater (arrow) helps protect Gordons Landing, which serves as a terminal for ferry service across Lake Champlain to Cumberland Head in Plattsburgh Harbor, New York.*



*The project on the Narrows of Lake Champlain consists of a 13.5-mile-long channel extending northerly from the canal lock at Whitehall, New York, to Benson Landing in Benson. The photo shows the beginning of the project at the canal lock (bottom) in Whitehall.*



*With a length of 105 miles, Otter Creek is the longest river in Vermont. The Corps' project consists of an eight-mile-long channel extending from Lake Champlain at Ferrisburg to the falls at Vergennes (above, left). An eight-foot-deep turning basin lies in front of the falls.*

## Otter Creek

Otter Creek, the longest river in Vermont, rises on the northern slope of Dorset Mountain, part of the Green Mountain Range, in Dorset and flows in a north/northwesterly direction for 105 miles. It empties into Lake Champlain at Ferrisburg, about 54 miles south of the United States-Canada border and 18 miles south of Burlington. Otter Creek is used by a small recreational fleet.

The project, completed in 1900, consists of:

- An eight-mile-long channel, eight feet deep and 100 feet wide, extending from Lake Champlain at Ferrisburg to the falls at Vergennes; and
- An eight-foot-deep turning basin at the falls in Vergennes. The original project also called for the removal of two small rock areas in the channel; however, existing conditions are considered adequate for the needs of present navigation.

From its source in Dorset, Otter Creek flows northerly for 33 miles through Danby, Mount Tabor, Wallingford, Clarendon, and Rutland. The river then changes its course northwesterly for 72 miles through West Rutland, Proctor, Pittsford, Brandon, Sudbury, Leicester, Whiting, Salisbury, Cornwall, Middlebury, Weybridge, New Haven, Addison, Waltham, Panton, and Vergennes before emptying into Lake Champlain at Ferrisburg.

## St. Albans Harbor

St. Albans Harbor in St. Albans is located on the northeastern shore of St. Albans Bay in Lake Champlain, about 15 miles south of the United States-Canada border and 35 miles north of Burlington. The harbor is used mainly for recreational boating.

The project involved removing boulders and other obstructions in the vicinity of the wharves to a depth of 6.5 feet. Completed in 1913, the project improved accessibility to the wharves and navigational safety for boats carrying passengers and freight.

## Swanton Harbor

Swanton Harbor in Swanton is located in Maquam Bay, which indents the eastern shore of Lake Champlain and is seven miles south of the United States-Canada border.

The project consists of a 300-foot-long breakwater and has an interesting history. In 1872, officials from the Portland and Ogdensburgh Railroad Company informed the Corps of Engineers that the company would be expanding into Swanton Harbor and constructing depot buildings and wharves in the harbor's upper end. After a survey, the Corps recommended the construction of a breakwater in the upper harbor to protect the railroad company's proposed buildings and other anticipat-



*St. Albans Harbor is used mainly for recreational boating. The Corps removed boulders and other obstructions in the vicinity of the wharves to a depth of 6.5 feet.*

ed business development in the upper harbor. It was suggested by the Corps that the breakwater be constructed in sections; as harbor development grew, the breakwater would be extended to protect additional commerce. To completely protect the proposed structures in the upper harbor that the Portland and Ogdensburgh Railroad Company planned to build, the Corps calculated that the breakwater should have a final length of 1,900 feet.

Initial construction of the breakwater began in the mid 1870s. When the railroad company expanded into Swanton Harbor in 1877, however, its buildings were constructed in the lower harbor, far removed from any protection provided by the breakwater in the upper harbor. Although the first section of breakwater, 300 feet long, was completed in 1883, the railroad company's change of business location made the matter of extending the breakwater questionable, since the structure at that time was not protecting any development.

During the ensuing years, anticipated commerce failed to materialize and the breakwater was not extended. No commerce has been reported in the harbor since 1889.

# Shore and Bank Protection

Vermont has approximately 4,936 miles of rivers and streams. The Corps has constructed two bank protection projects in the state which stem riverbank erosion and cost an aggregate \$250,500 to construct.

Vermont is the only New England state without a shoreline on the Atlantic Ocean. However, Lake Champlain is surrounded by a 587-mile-long shoreline, which includes the shorelines

of islands contained within the lake and is longer than the Atlantic Ocean shorelines of New Hampshire, Connecticut, and Rhode Island. Of these 587 miles, 380 miles lie in Vermont, 183 miles lie in New York, and 24 in Quebec. The shoreline of Lake Champlain's perimeter, excluding the shorelines of islands on the lake, totals 535 miles.



*The shore can take a beating from storm driven winds and waves. In September 1961, Hurricane Esther raised havoc with Rhode Island's Narragansett Pier, slamming waves against the seawall and flooding adjacent streets. (Copyright 1961 The Providence Journal Company).*

# SHORE AND BANK PROTECTION PROJECTS

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Mill Brook, Brownsville

Saxtons River, Rockingham



*The project on Mill Brook in Brownsville consists of a 120-foot-long concrete block retaining wall (arrow). The project protects Gleanor Grange Hall in West Windsor's Historical District.*

## Mill Brook, Brownsville

The project on Mill Brook is situated along the brook's northern bank in the Brownsville section of West Windsor, about 12 miles north of Springfield. The project lies adjacent to Gleanor Grange Hall in West Windsor's Historical District, about 150 feet upstream of the junction of Mill and Beaver Brooks.

Erosion along Mill Brook's northern bank from high velocity flows and ice jams brought the brook to within 13 feet of Gleanor Grange Hall's foundation and only five feet from the hall's fire escape. The eroding bank threatened to undermine several large trees and eventually the hall.

To stabilize the bank and maintain the integrity of the hall, the Corps constructed slope protection, consisting of interlocking concrete grid blocks, along 120 feet of streambank. The Corps also placed six to eight boulders, each with a diameter of about four feet, in the brook for fishery habitat. Built as a small project under Section 14 of the Continuing Authorities Program, the work at Mill Brook was constructed between June-October 1987 at a cost of \$110,000.

Mill Brook rises in Reading and flows in a generally easterly direction for 16 miles before entering the Connecticut River at Windsor. From Reading through West Windsor, Mill Brook flows in a northeasterly course for approximately 11 miles. Upon entering Windsor, Mill Brook flows initially in a southeasterly direction, then abruptly changes course and flows northerly into Mill Pond in Windsor. Upon leaving Mill Pond,

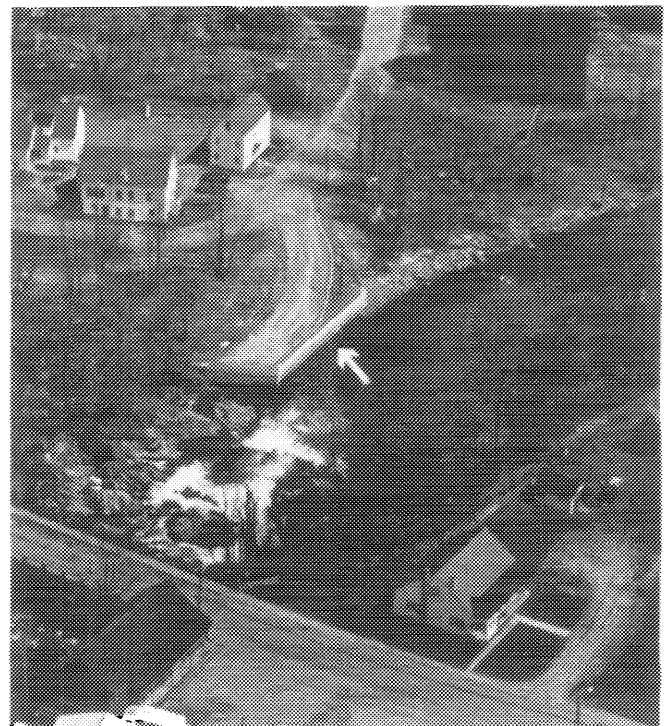
Mill Brook flows northeasterly for approximately one mile before entering the Connecticut River at Windsor.

## Saxtons River, Rockingham

The Saxtons River rises in Windham and flows southeasterly for 20 miles before joining the Connecticut River in Rockingham, approximately 22 miles north of Brattleboro and eight miles south of Springfield. The project is located on the north bank of the Saxtons River in the Saxtons River section of Rockingham, about 4.4 miles upstream of the rivers' confluence.

The high velocities of the Saxtons River during periods of flooding were causing erosion and frequent damage to an earth and gravel access ramp extending from a town road to the Saxtons River. The river is used as a water source by the fire department, and the access ramp, located at a primary pumping site, allowed firefighters ingress to the river. Because the ramp was not adequately protected to withstand the river's high velocities, it had to be repaired and maintained annually.

To protect the access ramp from further erosion damage, the Corps constructed a 175-foot-long retaining wall made of precast concrete blocks along the riverbank. The Corps also placed 260 feet of stone slope protection along the bank. Construction of the project began in September 1983 and was completed in January 1985 at a cost of \$140,500. It is a small project, built under Section 14 of the Continuing Authorities Program.



*A retaining wall (arrow), made of precast concrete blocks, protects an important access ramp in Rockingham from damage caused by Saxtons River floodwaters.*

# APPENDIX

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# Communities with Corps Projects

The communities listed below have either Corps' lands or Corps-built projects lying within their borders. The listing indicates the project name, its purpose (Flood Damage

Reduction, Navigation, or Shore and Bank Protection), and the page number in this booklet where the project is described.

<b>Community</b>	<b>Project Name</b>	
<i>Arlington</i>	Roaring Branch Local Protection Project (Flood Damage Reduction)	43
<i>Barre</i>	East Barre Dam (Flood Damage Reduction)	31
<i>Bennington</i>	Bennington Local Protection Project (Flood Damage Reduction)	40
	Roaring Branch Local Protection Project (Flood Damage Reduction)	43
<i>Benson</i>	Narrows of Lake Champlain (Navigation)	51
<i>Berlin</i>	Winooski River Local Protection Project (Flood (Damage Reduction)	45
<i>Burlington</i>	Burlington Harbor (Navigation)	50
<i>Cambridge</i>	Lamoille River Local Protection Project (Flood Damage Reduction)	42
<i>Ferrisburg</i>	Otter Creek (Navigation)	52
<i>Grand Isle</i>	Channel Between North & South Hero Islands (Navigation)	50
	Gordons Landing (Navigation)	51
<i>Hardwick</i>	Lamoille River Local Protection Project (Flood Damage Reduction)	42
<i>Hartford</i>	Hartford Local Protection Project (Flood Damage Reduction)	41
	North Hartland Lake (Flood Damage Reduction)	32
<i>Hartland</i>	North Hartland Lake (Flood Damage Reduction)	32
<i>Hyde Park</i>	Lamoille River Local Protection Project (Flood Damage Reduction)	42
<i>Jamaica</i>	Ball Mountain Lake (Flood Damage Reduction)	30
	Townshend Lake (Flood Damage Reduction)	34
<i>Johnson</i>	Lamoille River Local Protection Project (Flood Damage Reduction)	42
<i>Londonderry</i>	Ball Mountain Lake (Flood Damage Reduction)	30
<i>Middlesex</i>	Winooski River Local Protection Project (Flood Damage Reduction)	45
	Wrightsville Reservoir (Flood Damage Reduction)	37
<i>Montpelier</i>	Bailey Dam Local Protection Project (Flood Damage Reduction)	40
	Winooski River Local Protection Project (Flood Damage Reduction)	44
	Wrightsville Reservoir (Flood Damage Reduction)	37
<i>Moretown</i>	Winooski River Local Protection Project (Flood Damage Reduction)	44
<i>Morristown</i>	Lamoille River Local Protection Project (Flood Damage Reduction)	42
<i>North Hero</i>	Channel Between North & South Hero Islands (Navigation)	50
<i>Orange</i>	East Barre Dam (Flood Damage Reduction)	31
<i>Richford</i>	Richford Local Protection Project (Flood Damage Reduction)	42
<i>Rockingham</i>	Saxtons River (Shore and Bank Protection)	56
<i>Saint Albans</i>	Saint Albans Harbor (Navigation)	52
<i>Springfield</i>	North Springfield Lake (Flood Damage Reduction)	33

<i>Stowe</i>	Waterbury Reservoir (Flood Damage Reduction)	36
<i>Swanton</i>	Swanton Harbor (Navigation)	52
<i>Thetford</i>	Union Village Dam (Flood Damage Reduction)	34
<i>Townshend</i>	Townshend Lake (Flood Damage Reduction)	34
<i>Vergennes</i>	Otter Creek (Navigation)	52
<i>Washington</i>	East Barre Dam (Flood Damage Reduction)	31
<i>Waterbury</i>	Waterbury Reservoir (Flood Damage Reduction)	36
<i>Weathersfield</i>	North Springfield Lake (Flood Damage Reduction)	33
<i>West Haven</i>	Narrows of Lake Champlain (Navigation)	51
<i>West Windsor</i>	Mill Brook (Shore and Bank Protection)	56
<i>Weston</i>	Weston Local Protection Project (Flood Damage Reduction)	44
<i>Whitehall, N.Y.</i>	Narrows of Lake Champlain (Navigation)	51
<i>Wolcott</i>	Lamoille River Local Protection Project (Flood Damage Reduction)	42

# Glossary

**Anchorage**—an area dredged to a certain depth to allow boats and ships to moor or anchor.

**Bedrock**—rock of relatively great thickness lying in its native location.

**Breakwaters**—structures, usually built offshore, that protect the shoreline, harbor, channels, and anchorages by intercepting the energy of approaching waves.

**Bulkheads**—steel sheet piling or timber walls that prevent sliding of the land and protect the streambank or shoreline from erosion.

**Conduits**—concrete tunnels or pipes that divert floodwaters around or under potential flood damage sites.

**Culverts**—large pipes, usually constructed below bridges and other water crossings, that allow water to pass downstream and provide support to the crossing.

**Dikes**—earthfill barriers that confine floodwaters to the river channel, protecting flood prone areas.

**Drainage Area**—the total land area where surface water runs off and collects in a stream or series of streams that make up a single watershed.

**Drop Structure**—a device in a stream or channel that prevents water from rising above a certain elevation. Once water reaches a certain level, excess water passes over the structure and is diverted to another body of water.

**Earthfill**—a well graded mixture of soil containing principally gravel, sand, silt, and clay, which is used with other materials to construct dams, dikes, and hurricane protection barriers.

**Environmental Assessment**—an examination of the positive and adverse impacts on the environment of a proposed water resources solution and alternative solutions.

**Environmental Impact Statement**—a detailed environmental analysis and documentation of a proposed water resources solution when the proposed solution is expected to have a significant effect on the quality of the human environment or the area's ecology.

**Feasibility Study**—a detailed investigation, conducted after the reconnaissance study is completed, that recommends a specific solution to a water resource problem.

**Floodplain**—the land adjoining a river, stream, ocean, or lake that is likely to be flooded during periods of excess precipitation or abnormal high tide.

**Floodproofing**—structural measures incorporated in the design of planned buildings or alterations added to existing ones that lessen the potential for flood damage. For example, existing structures could have their basement windows blocked, or structures in the design stage could be built on stilts or high foundations.

**Floodwalls**—reinforced concrete walls that act as barriers against floodwaters and confine them to the river channel, protecting flood prone areas. Floodwalls are usually built in areas with a limited amount of space.

**Gabion Wall**—a retaining wall constructed of stone-filled wire mesh baskets.

**Groins**—structures that extend perpendicular from the shore in a fingerlike manner to trap and retain sand, retarding erosion and maintaining shore alignment and stability.

**Hurricane Protection Barriers**—structures built across harbors or near the shoreline that protect communities from tidal surges and coastal storm flooding. They are often constructed with openings for navigational purposes.

**Intake Structure**—found at the entrance to a conduit or other outlet facility, an intake structure allows water to drain from a reservoir or river and is equipped with a trash rack or other feature that prevents clogging from floating debris.

**Jetties**—structures that stabilize a channel by preventing the buildup of sediment and directing and confining the channel's tidal flow. Jetties are usually built at the mouth of rivers and extend perpendicular from the shore.

**Outlet Works**—gated conduits, usually located at the base of a dam, that regulate the discharge of water.

**Pumping Station**—a structure containing pumps that discharges floodwaters from a protected area over or through a dike or floodwall and into a river or ocean.

**Reconnaissance Study**—a preliminary study that examines a wide range of potential solutions to a water resources problem, each of which is reviewed for its economic and engineering practicality, acceptability, and impact on the environment.

**Recreation Pool**—any permanent body of water impounded by a dam that offers recreational opportunities or promotes fishery and wildlife habitat.

**Retaining Walls**—walls made of stone, reinforced concrete, precast concrete blocks, or gabion that support streambanks weakened by erosion.

**Revetment**—a facing of stone or concrete constructed along a backshore or riverbank to protect against erosion or flooding.

**Sand Drain**—a layer of pervious materials, such as sand and gravel, placed beneath the downstream section of a dam that carries seepage to the dam's downstream limits and out into the stream.

**Sand Replenishment**—quantities of sand placed on a shoreline to restore or widen a beach's dimensions. Sand replenishment strengthens beaches affected by erosion, protects the backshore from wave action, and stops the inland advance of water.

**Seawall**—a reinforced concrete wall built along a shoreline to protect against erosion or flooding.

**Snagging and Clearing**—the removal of accumulated snags and debris, such as fallen trees, dead brush, and silt, from river and stream channels. Snagging and clearing improves a channel's flow capacity and eliminates a potentially dangerous flood situation.

**Spillway**.....a channel-shaped structure, usually made of concrete or excavated in rock, that allows water exceeding the storage capacity of a reservoir to pass through or around a dam instead of overtopping it.

**Stone Slope Protection**..... a layer of large stones, usually underlain by a layer of gravel bedding, designed to prevent erosion from streamflow, wave attack, and runoff.

**Stoplog Structure**..... a designed opening in a floodwall or dike that allows the passage of water during non-flood periods but closes during flood periods to prevent flooding downstream. Stoplog structures can be made of wood or steel or concrete beams.

**Training Dike**..... a structure extending from the shore into the water that redirects the current, preventing sediment

from settling and ensuring that adequate depths are maintained.

**Training Wall**.....a structure built along channel banks to narrow the channel area, thereby controlling the velocity of the flow of water and preventing the buildup of sediment. Training walls and training dikes have the same purpose: to ensure adequate depths are maintained.

**Vehicular Gate**..... an opening in a dike or floodwall that allows rail cars or other vehicles to pass over the structure during nonflood periods. Vehicular gates can be closed during flood periods by either stoplogs or large steel gates.

**Weir**.....a concrete structure designed as part of the spillway that allows water to flow from the reservoir and over the spillway.

# Index

Appendix	57	Local Protection Projects	39
Authorization and Planning Process for Water Resource Projects	6	Mill Brook, Brownsville	56
Bailey Dam, Montpelier Local Protection Project	40	Narrows of Lake Champlain	51
Ball Mountain Lake	30	Navigation (General)	46
Bennington Local Protection Project	40	Navigation (Projects)	47
Burlington Harbor	50	North Hartland Lake	32
		North Springfield Lake	33
Channel Between the North and South Hero Islands	50		
Civil Works Overview	3	Otter Creek	52
Communities with Corps' Projects (Alphabetical Listing)	58	Recreation	20
Connecticut River Basin	25	Regulatory Programs	19
		Richford Local Protection Project	42
Dams and Reservoirs	29	River Basins	24
Description of Projects	23	Roaring Branch, Arlington Local Protection Project	43
		Roaring Branch, Bennington Local Protection Project	43
East Barre Dam	31	Saint Albans Harbor	52
Emergency Response and Recovery	21	Saxtons River, Rockingham	56
Environmental Quality	18	Shore and Bank Protection (General)	55
		Swanton Harbor	52
Flood Control and Flood Plain Management	7		
Flooding in New England	9	Townshend Lake	34
Glossary	60		
Gordons Landing	51	Union Village Dam	34
		U.S. Army Corps of Engineers Programs and Services	1
Hartford Local Protection Project	41	Water Supply	18
Hudson River Basin	26	Waterbury Reservoir	36
Hydropower	17	Weston Local Protection Project	44
		Winooski River, Middlesex and Montpelier Local Protection Project	44
Introduction	4	Wrightsville Reservoir	37
Lake Champlain Basin	27		
Lamoille River, Cambridge and Hardwick Local Protection Project	42		

Public Affairs Office  
New England Division  
U.S. Army Corps of Engineers  
424 Trapelo Road  
Waltham, MA 02254-9149

Bulk Rate  
U.S. Postage  
Paid  
Waltham, MA  
Permit No. 56723

Meter Code 40

NEDEP-360-1-37

Publication supercedes all previous editions.  
Revised as of November 1995